FACTORY MANAGEMENT COURSE AND SERVICE

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TO MY WIFE
MARY DODGE FICKER

PREFACE

The ultimate objective of all cost finding is executive control, by means of which all forms of waste may be eliminated. It is a lamentable fact, however, that there are still many executives of industrial enterprises who look upon the compilation of their production costs as nothing more or less than a bookkeeping fiction. Shop costs, when compiled under the direction of such men, are practically worthless.

The fact that cost accounting is only a single phase of cost finding is the important point which is usually lost sight of. Cost accounting deals with the treatment of the data pertaining to costs after such data have once been collected. Cost finding embraces not only the accounting phase, but also the collection of the data which makes such accounting possible. The purpose of this treatise is to acquaint the student with both the collection and accounting phases of industrial cost finding, without attempting to infringe upon the field of general financial accounting practice, which is now thoroughly standardized and universally adopted.

Notwithstanding the commendable progress which has been made during the past ten years in the direction of standardization, it is important not to overlook the fact that much further progress must be made before anything approaching a fixed universal cost policy will be possible of attainment. The author has endeavored to present in this treatise what he considers to be the best examples of present-day practice.

The subject, however, is one which offers the possibility of introducing such a large number of minor exceptions, that to cover them all would not only be inadvisable but, further, would be impossible in a treatment of this kind. The dovetailing of these exceptions into the general scheme herein laid down, has been left to the common sense of the reader.

While the author has drawn on his personal experience for most of the material contained in this book, he is greatly indebted to those who, by their co-operation in the way of placing data and methods at his disposal, have greatly lightened the labor incidental to their compilation.

NICHOLAS THIEL FICKER.

TABLE OF CONTENTS.

CHAPTER I

THE ECONOMICS OF COST ACCOUNTING

CHAPTER II

CLASSIFICATION OF PLANT ACCOUNTS

CHAPTER III

CLASSIFICATION OF PLANT ACCOUNTS (*Cont.*)

CHAPTER IV

FUNCTIONS OF CONTROLLING AND SUBSIDIARY LEDGER ACCOUNTS

CHAPTER V

THE LABOR FACTOR

CHAPTER VI

TIME-KEEPING AND LABOR COST FINDING

CHAPTER VII

"MECHANISM" OF TIME-KEEPING

CHAPTER VIII

RELATION OF INSPECTION TO COSTS

CHAPTER IX

PURCHASES AND STORES ACCOUNTING

CHAPTER X

STORES ACCOUNTING

CHAPTER XI

THE DISTRIBUTION OF SHOP EXPENSE

CHAPTER XII

ESTABLISHING A BASIS FOR DISTRIBUTING MACHINE AND MATERIAL EXPENSE

CHAPTER XIII

POWER EXPENSE, ANALYSIS AND DISTRIBUTION

CHAPTER XIV

RENT EXPENSE ANALYSIS AND DISTRIBUTION

CHAPTER XV

DEPRECIATION ACCOUNTING

CHAPTER XVI

INSURANCE, TAXES, AND INTEREST

CHAPTER XVII

TOOL AND SPECIAL INVESTIGATION EXPENSE

CHAPTER XVIII

MATERIAL EXPENSE, WASTE, AND IDLE LABOR

CHAPTER XXI

SPECIAL PROCESS EXPENSE UNITS

CHAPTER XXII

CURRENT VARIATION RATIOS AND THE SUPPLEMENTARY RATE

CHAPTER XXIII

EXECUTIVE CONTROL OVER PRODUCTION COSTS

CHAPTER XXIV

COST SUMMARIES

INDUSTRIAL COST FINDING

CHAPTER I

THE ECONOMICS OF COST ACCOUNTING

The Cost of Ignorance.—Twenty-five billion dollars' worth of capital, according to recent statistics, is employed in manufacturing throughout the United States. This amount is divided approximately among three hundred thousand manufacturing establishments which employ about ten million people, or the equivalent of almost one-tenth of the continental population of the country. The original cost of raw materials is increased through manufacturing to something over ten billion dollars a year. And yet, according to an investigation made by the Federal Trade Commission more than one hundred thousand of these manufacturing establishments do not earn a penny, and only ten per cent of them know what it actually costs them to manufacture their products; forty per cent simply estimate their costs, and fifty per cent have no method whatever of knowing what these costs are.

This, in brief, then, represents the industrial status of the country today from a purely manufacturing viewpoint. The extent of the economic waste which is being incurred each year through ignorance on the

part of this large percentage of manufacturers is undoubtedly tremendous, but it escapes attention simply because ninety per cent of these manufacturing plants under the existing conditions, have no means of ascertaining this waste.

Out of sixty thousand corporations doing an average business of at least one hundred thousand dollars a year, thirty thousand, or fifty per cent, make no provision for writing off depreciation or for creating reserves for the replacement of worn out plant and equipment. In many instances whole industries are suffering because of inadequate cost finding methods and a failure to appreciate the importance of cost accounting. In the face of these figures the old theory that cost finding methods and cost accounting procedure are not essential to successful plant operation is absurd. That they are essential and are needed by all modern establishments in the successful carrying on of their business is a matter of fact and record. It is significant, therefore, to appreciate the field of cost accounting as measured by these 270,000 plants which are not yet on a firm footing, and also the effect, through the knowledge and experience gained, which this ultimate achievement will have on the standardization of cost finding.

Louis D. Brandeis, Justice of the Supreme Court, speaking before the Economic Club of New York on "The New Conception of Industrial Efficiency," said:

> The prosperity of the South began with the cotton gin; the prosperity of the West lay not so much in her fertile fields as in her agricultural machinery and in her transportation system which enabled us to eliminate waste, to create a field

for profit out of which we, and all of us, were able to get a living better than was obtained in foreign countries. In our New England, and in parts of the East where manufacturing prevails, it has been our necessities and not our resources that have been the source of prosperity. It has been the necessities, the poor soil, which drove us to manufacturing and high wages. Unfortunately that movement to invent, to save labor, was arrested. Why? Because of the illimitable resources of foreign labor. It was easier to tap the foreign labor supply than to think and to work persistently upon the lines of saving labor.

The manufacturers of this country, because of the great world conflict, are face to face with a situation which had not previously arisen in our industrial history. The manufacturers of Europe have been awakened from their lethargy; spurred on by patriotism, and in many cases through the pressure of their own governments, they have been forced to attain a degree of operating efficiency far above that which existed or which was thought possible before the beginning of the war.

To keep pace with this abnormal development and with the trade rivalry brought about by this conflict, it is of vital importance that all manufacturing work in this country be put on a firmer basis than that which has previously existed.

History of Industrial Growth.—The history of industrialism dates from the beginning of the history of man. In the fourth chapter of Genesis we find reference made to a Tubal Cain, a man spoken of as "the forger of cutting instruments of brass and iron." The history of ancient Egypt shows that her industries were a counterpart of those of our own time. Her brickmaking, weaving, glassblowing, pot-

tery making, iron working, and other industries have come down to us with only slight modifications. In fact, up to the beginning of the nineteenth century the progress in industrial methods from the days of ancient Egypt was hardly worth considering. Even today bricks are being laid precisely as they were laid in the days of Pharoah.

The beginning of the nineteenth century, however, saw the introduction of machinery; and from that time on we have been living in what might properly be called the second period of industrialism. Because of the fact that hand labor could be replaced by machinery, and because of the gradual development and perfection of this machinery up to the point where these machines have become, in a great many instances, entirely automatic in their operation, the development of industrialism from a manufacturing viewpoint has been greater since the beginning of the nineteenth century than in all of the eighteen centuries preceding it.

Depleted Resources Demand Closer Economies.—We are to-day confronted with a rapidly diminishing supply of natural resources. When our forests were plentifully supplied with timber, the question of fuel, for example, was one which did not have to be reckoned with. When our supply of iron ore was greater than our heaviest demands, we did not have to be conservative in our use of it. When our supply of hard woods seemed inexhaustible, the cost of lumber was not an important factor. When our supply of labor was far in excess of the demand, it was not necessary to perfect the work of the indi-

vidual workman simply because additional workmen could be employed at a very low rate of pay. On top of these reasons was the fact that the margin between cost and selling price was much greater than it is to-day.

These conditions, however, do not now exist. Trained and skilled workmen are required to operate our machines to-day, and we are therefore forced to pay a much higher scale of wages. Raw materials, which a century ago were in abundance, have become so scarce in many instances that we must either import them from other countries or find substitutes for them. Our natural resources, especially those of coal, lumber, and iron, have been depleted on such a scale that our manufacturers to-day are forced to pay an almost prohibitive price for them.

We are, then, brought face to face with the only possible manner by which a reduction in costs can be accomplished. This alternative is through efficient plant management, which will reduce to the lowest possible degree all of the factors of waste in their various forms that enter into manufacturing. We are forced to resort to time studies of work in order that all lost efforts may be remedied. We are forced to utilize by-products of manufacturing which, when converted into some other form, will become a source of revenue. We are forced to choose between certain types of organization and adopt the one which has been found most suitable for specific lines of production. We are forced to plan and route the the work in our factories to the end that idle time may be reduced to a minimum; that machines will be

kept busy; that all available floor space will be utilized for manufacturing purposes, and that stock on hand does not exceed certain maximum nor fall below certain minimum limitations. Furthermore, we are obliged to adopt and put into operation, methods of wage payment which will be conducive to the greatest volume of production and quality of work; and finally we find it necessary to analyze and segregate all indirect expenses incidental to manufacturing in such a way as to limit their extent for different degrees of shop activity.

Scientific cost finding methods, therefore, are seen to be essential to successful plant operation; without them, manufacturers are simply gambling with their own destinies. The time has come when it is no longer possible to do business on a hit-and-miss basis. A manufacturer who can bid on, or contract for work with the positive assurance that his figures not only will get him the business, but also will net him a fair profit has nothing to fear from a competitor who has no accurate method of arriving at his actual costs, and who makes his estimates and sells his goods on guess work.

Cost accounting to-day is in its infancy. It will be many years before it is so standardized that it may be called a science. There are certain fundamental principles, however, that have already been established, and that can be used as a foundation on which to build the superstructure of cost standardization and determination. It is impossible to estimate just how long the period will be before cost accounting has become so standardized that a universal

method of arriving at production facts may be obtained, for it depends entirely upon the success that the exponents of adequate cost finding methods have in convincing the manufacturers of the country of the vital importance which this subject bears to their success.

Value of Manufacturing Statistics.—Today probably no better medium of exchanging and collecting information of mutual benefit exists than through the various manufacturers' trade associations. In the past, manufacturers have been prone to look upon an exchange of experiences with their competitors as detrimental to their own interests. To-day, however, this is not true. Experiences and statistics pertaining to production and operating costs, production routine, storing and shipping, and methods of handling employees are being gathered and tabulated by trade associations for the benefit of all of their members. The results already obtained by this exchange of experiences have made increased efficiency possible in so many instances that it is now looked upon as almost a necessity.

Whether or not this medium of collecting manufacturing statistics is the one most conducive to increased efficiency in all lines of production is a question which has yet to be answered. In all probability some neutral organization will be developed eventually, either under the jurisdiction of federal or private enterprise, whose business it will be to collect and assemble manufacturing data in a form suitable for distribution to all manufacturers alike throughout the country.

A large number of points relating to cost accounting and plant operation have not as yet been firmly established. A notable illustration of this is in connection with the subject of depreciation. Here we find a diversity of opinion regarding the service value of plant and equipment, and the best method of creating reserves for depreciation and replacement. The main difficulty is that there is not sufficient information available at the present time to permit us to predetermine the probable life of the various equipment which we may eventually have to replace. From a cost accounting standpoint the allotment of depreciation has had a vital effect on the method of ascertaining true costs of production. When we stop to consider, for instance, that depreciation, which forms so large a part of the overhead expenses of a factory, is only being provided for in ten per cent of our manufacturing establishments, and, furthermore, when we realize that there will come a time when a large part of the equipment in any one of these factories will wear out at about the same period and that the replacements, which will have to be made, will not only eat up the entire profits of the year in which they occur, but also for several years to come in all probability, some idea of the magnitude of this subject will be appreciated.

The importance of persuading manufacturers to exchange their experiences, not only on this subject of depreciation, but on all of the many other factors relating to plant operation and production, therefore, will be easily understood by any student of the subject.

Blind Competition.—The reason why so large a part of our manufacturers are not making money or why they are actually losing money is because they do not know how to conduct their business. They fail to appreciate the fact that if they would properly control certain elements that enter into the manufacture of their products they would effect a very material reduction, in many instances, in their costs of manufacture. This ignorance, or failure to appreciate what can be accomplished by a systematic diagnosis of manufacturing conditions, compels such a manufacturer to conduct his business blindly on the basis of what a competitor may be doing. It stands to reason, therefore, that a competitor, who is operating his plant on a scientific basis and is effecting economies thereby, can naturally sell at a price that is often lower than what it actually costs the first manufacturer, who has not appreciated the significance of true costs, to produce his goods. Selling prices established by the first manufacturer therefore, on the basis of what his efficient competitor is doing, cannot fail, eventually, to result in his own ruin.

It is of paramount importance, therefore, to realize to what extent business is being carried on in just such a hit or miss principle, and how the economic condition of the country as a whole can be benefited by a thorough understanding of the results to be obtained through proper cost accounting procedure and practice.

An exchange of experiences and a comparison of methods pursued in the operation of manufacturing

establishments and in arriving at costs of production does not necessarily imply that the manufacturers participating in the exchange are obliged to divulge information which might be considered as more or less detrimental to their own interests, although this has been one of the obstacles which has had to be overcome.

Some of the essential points that can be discussed in such conferences, for example, are those relating simply to such questions as: Is each manufacturer including the same items in ascertaining his costs? Is proper provision for plant depreciation being made? Has one form or another of management worked out more successfully? From any of the many other phases of plant operation have certain lessons conducive of greater efficiency been learned? In fact, the object is not to force any information from a manufacturer other than that which he feels perfectly free to divulge. When this matter is presented in the proper manner, there is usually no hesitancy on the part of those who would so exchange their experiences to co-operate. In most cases a manufacturer who refused to join such a conference would immediately be placed in a poor strategic position even if he did not lose out in other ways.

Cost Defined.—What is cost, is a question often asked. The Federal Trade Commission has defined a cost "as the amount or equivalent paid, or charged, or given for anything; loss of any kind, expenditure, outlay, as of money, time, and labor. This equivalent may be in the form of money paid for material or for labor, or for some one of the many kinds of expense

or loss that exist in every manufacturing business. It is apparent that cost consists of three elements, viz., material, labor, and expense."

Labor and material are more or less tangible quantities, but manufacturing expense is the elusive, intangible factor in the solution of which most so-called cost finding systems fail. It is not difficult to ascertain the amount of labor and material which has actually been employed in producing a manufactured article, but it is impossible, without a well defined system of cost accounting, to decide just how much should be charged against this manufactured article for the overhead expenses of the factory, such as administration, power, rent, depreciation, insurance, taxes, idle labor, repairs and maintenance, defective work, tool expense, and others.

A Simple Cost Analysis.—Probably the best way of looking at this question of cost analysis is to consider each machine or each work-bench as paying for its own share of the above enumerated expenses. The simplest kind of manufacturing possible from this point of view would be that of a man operating his own machine in a small shed where he alone performed all of the actual productive work and where he purchased his power from some outside source. In such a case, naturally, all of the expense would be charged against the output of the only machine installed. Assume, simply for illustrative purposes, that a number of these small sheds adjoined each other, all owned and operated by individual workmen, then in each case the same condition would be true.

Suppose, however, that as their competition grew keener these individual proprietors decided to pool their interests and to pull down the partitions between their respective shops, converting the separate sheds into one single factory and housing the entire equipment under one roof. Suppose, further, that they also decided to employ some neutral man to act as their factory manager. In such a case the conditions would be exactly the same as they were under the individual method of operation, with the exception that the administrative expense would have to be assessed proportionately against all of the former proprietors who have now become a part of the one organization. If we assume that, as the business grew and expanded, each of the original proprietors have become heads of departments, then their salaries in turn would have to be assessed as administrative expense against their respective departments in addition to the pro rata charge for the general shop administration expense incurred by the manager of the factory and his staff.

This illustrates in a very simple manner the importance of segregating the overhead expenses of a factory so properly that each productive unit may be charged with its individual share. Naturally, there are many other charges besides administration expense which have to be distributed in this manner in every manufacturing plant, and the larger the plant the more care should be exercised in determining and assessing these charges. When we stop to consider that in a large percentage of establishments in the country today the overhead expenses chargeable

against the manufactured product in the course of any one year amount to more than the sum which has been expended for labor and raw materials, we may gain a fair appreciation of its importance.

Single Element Cost.—As an illustration of manufacturing in its simplest form let us consider an Indian sitting on the ground in the open and manufacturing baskets of grass by hand. Here we find that the only item of cost is the labor expended in gathering and weaving the grass into the required shape or form. The determination of costs in this case is very simple, as it is made up of only one element—labor. If we go a step further, however, and consider the same Indian working in the same place but employing his time in making pottery instead of grass baskets, we find that the cost of manufacture is made up of two elements instead of one.

To the labor expended by the workman in gathering his clay must now be added the expense of certain tools which he requires for cutting, molding, and shaping his raw material. These tools would, of course, be of the simplest nature, but nevertheless their very existence entails time and expense for producing them and to keeping them in suitable condition. The cost of producing such pottery would therefore have to include a certain charge for overhead expense also, which in this simple illustration, is made up of the depreciation and upkeep of the necessary tools.

Even in the simplest conceivable form of manufacturing, therefore, it will be seen that the cost is made up of a number of separate elements. And so the

various factors entering into manufacturing continue to grow more and more complex, until conditions similar to those which exist today in our large manufactories are found. Where the Indian manufacturing either his baskets or his pottery had the use of all of the light and space which he required without any expense to him, the modern manufacturer is compelled to erect buildings in order to provide the necessary working accommodations, to purchase or manufacture artificial light, to insure his buildings, and to provide for a thousand and one other items pertaining to maintenance, all of which have to be added to the cost of the manufactured product.

Two Types of Production.—Coming now to the subject of actual production, we find that it can be treated under two main divisions, "mass" and "unit" production respectively. The term "mass" production as here used includes such manufacturing as that done in sugar refineries, brass and steel rolling mills, flour mills, paper mills, paint factories, etc.; in other words, it is intended to include not only plants that produce only one thing, such as sugar, but any plant, such as a paint factory, where the work is more or less of a continuous process kind, although different kinds and grades of paint may be manufactured. "Unit" manufacturing is that performed by the average machine shop or wood-working factory which is engaged in the production of a number of different articles, and where the planning and actual production work varies for different jobs.

It will readily be seen from the foregoing illustrations of mass and unit production that quite

different methods have to be followed in obtaining the costs of production in each case. For example, a manufacturer of sewer pipe who is turning out many miles of pipe a day is not especially concerned about the cost of any one section of such pipe produced in the course of a day's work. But a manufacturer of specially built machinery who has a number of different orders for such special machines in process of manufacture, is vitally interested in the actual cost of producing each machine. Cost methods adopted by the manufacturer of sewer pipe, while perfectly satisfactory for his line of business, would in all probability not meet with the requirements of the manufacturer of special machines. And so we find that while the same elements, labor, material, and expense, enter into the cost of producing both the pipe and the machinery, a differentiation must be made in the methods of determining costs for these diametrically opposite lines of production.

Another important point to consider is that a large percentage of present day manufacturing is done on a basis of cost plus a fixed percentage. This is well illustrated, for instance, in the manufacture of telephone and telegraph equipment, or in the making of ammunition and war supplies, or in various kinds of experimental work. In such cases the manufacturer, although more or less concerned with what it is actually costing him to produce his factory output, is nevertheless not so vitally interested in exercising control over forms of waste as he would be if he were not working under the realization that he is fully protected by virtue of his "cost plus percentage of

profit'' contract, and that any losses incurred by him will be more than made up by his customers. In fact, in such instances as this, manufacturers have been known even to encourage wastefulness, since in this way they could add the percentage agreed upon to the extra time or material and derive additional profit therefrom.

The writer has cited these various illustrations for the purpose of showing that fixed and fast rules of cost finding cannot be made to apply to all cases. Many cost men who have been successful in standardizing methods in one line of manufacturing have made dismal failures of their work when undertaking the cost analysis of a different line simply because they did not appreciate this fact. There are certain fundamental principles, however, which have to be considered in each case and these principles must then be amplified so as to meet local conditions. But it need not be assumed because of these different cost viewpoints, that a mastery of cost accounting means the consideration of a maze of varying conditions. It does mean, however, that a cost system has to be built up step by step, and that each method selected must act as a support in building the complete structure which, when finished, will meet all requirements. It is the purpose of the writer to present these steps in their logical sequence in the following chapters.

CHAPTER II

CLASSIFICATION OF PLANT ACCOUNTS—

Grounds, Buildings, Permanent Fixtures

Definition of Plant Account.—The first requisite of a manufacturing business is a suitable place for the performance of work. Consequently in all cases, with the exception of those where space is rented, the first charges to be considered from an accounting standpoint are those which relate to the cost of grounds and buildings. Next in order come the charges for equipment, such as elevators, power plant, conduits, piping, electric light fixtures, storage tanks, which are known as permanent fixtures; and finally, the charges for machinery, tools, patterns, shop fixtures, and factory office furniture.

After these charges have been incurred they must be entered in the proper accounts in the general ledger. These accounts are called plant accounts, as they represent the cost of the plant and equipment. They are numbered as follows:

Account No. 1—Grounds.
Account No. 2—Buildings.
Account No. 3—Permanent Fixtures
Account No. 4—Machinery
Account No. 5—Small Tools
Account No. 6—Patterns
Account No. 7—Shop Fixtures
Account No. 8—Office Furniture (factory only).

These various plant charges should be entered in separate ledger accounts, rather than grouped under one account, as often found, where machinery, tools, and patterns, for example, are all charged to the same ledger account. The advantage of this special account method is found when charges, such as those for depreciation, insurance, and taxes, for instance, have to be made on the basis of the face values of plant and equipment indicated by these respective accounts.

Importance of Separating Plant Items.—Depreciation of machinery differs from depreciation of tools; while insurance is placed on the insurable value of the buildings and their contents, but not on the value of the ground on which such buildings were constructed. Values given in a ledger account called Grounds and Buildings would therefore need a segregation of the charges made therein before the face value of the buildings on which the insurance was to be placed could be established. It will be seen, therefore, that there are certain practical benefits to be derived from using specific rather than combination ledger accounts for recording the investment of the company in its plant and equipment.

When renewals to the plant are made, the original charges for transportation of plant equipment as well as any installation expense should be included with the cost of such equipment and should be charged to the specific plant account to which the cost of the equipment itself is charged. For example, when a worn-out machine is replaced by a new one the charge for the old machine is written off the ma-

chinery account and the net value, that is, the difference between the purchase price and the depreciation reserve, is charged to expense, the cost of the new machine being charged to the machinery account in lieu of the old one.

It frequently happens that one or more buildings are situated on a site which has been purchased for the erection of a new factory plant and have to be demolished before work on the new buildings can be started. In such cases, a part of the cost of demolishing the old structure may be charged to grounds account.

Tools and Patterns.—Here a distinction must be made at the time of purchase as to whether they are of a permanent or perishable nature. Perishable tools or temporary patterns are those whose existence will in all probability not exceed one year; they should be charged directly to expense and not to the tools or patterns accounts. This obviates charging them to the respective plant accounts and then making the adjustments for depreciation which, in the case of perishable tools or temporary patterns, would be one hundred per cent.

Importance of Classification.—Accountants and engineers alike experience considerable difficulty when trying to analyze the books of the average manufacturing establishment for auditing or appraisal purposes. Usually there is a large discrepancy between the plant assets as shown by their inventories and the assets as they appear on the books of the company. In most cases this is due to the fact that a conglomeration of charges appear on the plant accounts

of the company as assets when as a matter of fact no such total of assets can be found by a close investigation. This can usually be traced to a faulty system in the classification of charges. For example, an account called machinery and tools has probably been charged with the cost of the repairs and changes to tools or machinery in the course of the year. Likewise, the buildings account, in all likelihood, has been charged with the repairs and changes made to buildings. The result is that the machinery, tools, and buildings accounts all show inflated assets, whereas if these charges had been properly classified they would have been charged to the expense account of the factory instead of to the plant accounts. Not only does this method carry fictitious assets on the books of the company, but it also works an injury in that these items, which should have been charged to expense, have not been considered in the determination of the overhead which must be added on all work done in the factory. A comprehensive and well defined system of classification of accounts, therefore, is seen to constitute a large part in the success of any cost and accounting system.

Numerical System of Classification.—Many systems of classification are in use today, but none accomplishes the desired result more simply or more expeditiously than the numerical system. In this method each major account is numbered, as, for example, Machinery, Account No. 4; Tools, Account No. 5, and so forth.

Since it is often necessary to analyze these accounts further through a subsidiary ledger, items charged

to them must be subclassified in accordance with the requirements of the business. For example, it may be advisable for business reasons to divide Permanent Fixtures, Account No. 3, into permanent fixtures pertaining to buildings, power plant, water, or material; and in order to carry out the same numerical system, subclassification numbers, 001, 002, 003, 004, and so forth, are used to designate the charges according to these subdivisions. Under this arrangement a charge for permanent fixtures pertaining to power plant would be classified 3-002, whereby 3 would denote the ledger account and 002 the subclassification as carried on a page in the subsidiary ledger.

Departmental Classification.—This is carried still a step further when it is necessary to segregate charges by departments as especially required in the analysis of expense items. Each department should be assigned a specific number by which it is always known, such as the milling department, which might be designated as Department No. 510. Under such a system the charge for a machine purchased for the milling department could be classified 4-001-510, in which 4 would be the account number, 001 the class of machine, and 510 the department for which the machine was purchased. The reason why zeros are prefixed before the numbers is to avoid errors when punching cards for use on tabulating and sorting machines.

A careful study of this numerical system of classification will show that it has practically an unlimited range and permits all charges to be allocated easily, whether incurred for plant equipment or as expense.

In practice the routine simply necessitates that all bills be classified as they are received. A classification clerk usually attends to this by noting the proper classification either on the front or back of the bill. At the end of each month the bills are simply sorted according to account numbers and the totals are charged to the respective accounts. Afterwards they are further sorted under the account subclassifications and these totals are then posted in a subsidiary ledger. Naturally, the total of all charges shown on the subsidiary ledger must equal the total charge made to the controlling account on the general ledger. Where further detail of departmental charges is required the same method is followed and the totals for each department are posted against its account in a departmental expense ledger.

Department Expenses.—It should be understood that those charges made to departments include only charges for expense and not those for plant equipment, such as machinery, tools, etc. The object of allocating expense charges by departments is to obtain the amount of expense incurred by each department during a specific period, in order that the management may exercise the proper control over them. It is also for the purpose of ascertaining the amount of overhead or indirect expense assessable against each manufacturing department.

The purpose of classifying plant equipment, such as machinery and tools, by departments is to make possible the easy location of all the equipment. Usually this is done by assigning a number to each machine, whether made or purchased; filling out a

card with this number, and filing the cards according to the respective machine numbers. The cards, then, show the location of each machine in the factory and its cost. Later on, these cards can be re-assorted according to departments and the total investment in equipment in each department be easily obtained.

From the foregoing brief outline of the numerical system of classifying accounts it will be apparent that such a system must be carefully planned with due regard to the functions which it has to perform. In most well organized manufacturing establishments the classification lists are printed in pamphlet or book form for reference purposes. Clerks assigned to classification work soon become very skilled in its usage, and after a short time are able to classify most charges from memory. While it is not always possible to anticipate the requirements of an accounting and cost system, any numerical system of classifications, such as the one here outlined, allows additions to be made from time to time without in any way interfering with the general scheme.

Classification of Buildings Account.—Taking up again the question of classification of plant accounts, the first to require subclassification is the "buildings account." While it is not actually necessary for practical operating purposes to know the various costs in detail of buildings constructed for or by the company, it is often of benefit in later years to be able to refer to these original costs, especially when further construction work is contemplated or in the event of fire. In the latter case, it is much easier to substantiate insurable values by means of these original

charges. The following list of subclassifications of the buildings account is not necessarily a standard for any and all manufactories, but is simply an illustration of the method of segregating the charges according to the class of work carried on. This account is carried under the heading, Buildings, Account No. 2.

2-001—Architects fees, Engineering, and Inspection

2-002—Excavation

2-003—Foundations

2-004—General Masonry Work:

2-004-001—Walls (brick, concrete, stone, or tile)

2-004-002—Exterior Stone (special and terra cotta) includes lintels, sills, water tables, coping, cutstone, etc.)

2-004-003—Roof (concrete, tile, etc.)

2-004-004—Floors (concrete, tile, etc.)

2-004-005—Interior Stone and Tile Work

2-004-006—Plastering

2-005—Metal Work:

2-005-001—Structural Iron and Steel (columns, girders, trusses, floor beams, anchors, etc.)

2-005-002—Ornamental Metal Work

2-005-003—Sheet Metal and Miscellaneous Metal Work (metal roofs, steel siding, metal doors and windows, flashing, gutters, iron railings, metal ceilings, etc.)

2-006—Wood Work:

2-006-001—Structural Wood Work (girders, beams, columns, joists, purlins, studs, lath, bridging, etc.)

2-006-002—Roofing, Flooring, and Siding

2-006-003—Millwork (doors, windows, railing, baseboards, mouldings, etc.)

2-007—Plumbing, Sewer, Water, and Gas connections from the main headers in building to the street

2-008—Special Chimneys and Stacks

2-009—Miscellaneous (all items not included under the above classifications, such as special roof coverings, etc., unless they are of a nature justifying a special classification).

The method of subclassifying accounts as shown above for the buildings account can be adapted to practically any requirements. Where further information is needed, the subclassification numbers can simply be expanded to conform thereto. In the above list a charge for ornamental metal work, for example, would be classified as 2-005-002, by which would be indicated the account number (2), the kind of work (metal work-005), and the class of metal work (ornamental-002). By this method charges to the various accounts are easily allocated and the total expenditures for any one class may be determined. It sometimes happens in the construction of a building that special piling has to be sunk before the foundations can be built. The cost of this class of work is usually quite expensive and, if not properly segregated, would in all probability be charged in with the cost of the foundations. It is advisable, therefore, to charge the cost of such work as this to some subclassification other than "foundations," for the reason that when insurable values are being determined, deductions would have to be made for such piling foundations. Many other instances of just this kind become apparent only when construction costs are segregated in a manner similar to that outlined.

It should be thoroughly understood that these sub-

classifications are not separate general ledger accounts, but are simply carried as special sub-accounts on the subsidiary ledger. The function of this subsidiary ledger is purely analytical and in no way affects the controlling accounts on the general ledger of the company.

Classification of Permanent-Fixtures Account.—A permanent fixture is a structure, installation, or apparatus, more or less a part of the building itself, which has a position or value regardless of occupant and which at no time is used directly in a productive capacity. Following the foregoing classification scheme, this account is designated, Permanent Fixtures, Account No. 3.

Permanent fixtures may be arbitrarily divided into four main divisions as follows:

3-001—Permanent Fixtures pertaining to Buildings
3-002—Permanent Fixtures pertaining to Power Plant
3-003—Permanent Fixtures pertaining to Water
3-004—Permanent Fixtures pertaining to Material.

Permanent Fixtures Pertaining to Buildings.—Under this classification would be included the following:

3-001-001—Passenger Elevators
3-001-002—Pumps
3-001-003—Piping and Fittings
3-001-004—Underground Conduit Systems (other than for Power Distribution)
3-001-005—Pneumatic Tubes
3-001-006—House Telephone System
3-001-007—Electric Heating System

3-001-008—Steam Heating System
3-001-009—Hot Air Heating System
3-001-010—Hot Water Heating System
3-001-011—Gas Illuminating System
3-001-012—Fences
3-001-013—Gates
3-001-014—Gate Keepers' and Watchmen's Houses.

Permanent Fixtures Pertaining to Power Plant.—Items under this heading are segregated according to the respective power systems as follows:

3-002-001—Steam Generating System
3-002-002—Steam Distributing System
3-002-003—Electric Current Generating System
3-002-004—Electric Current Distributing System
3-002-005—Mechanical Tranmission System
3-002-006—Compressed Air System
3-002-007—Electric Illuminating System.

Under the subclassification Steam Generating System (Account No. 3-002-001) would be included all fixtures used within the boiler room, such as boilers and boiler fittings; ash and coal conveyors and their foundations; pumps, feed water heaters and connections; coal bunkers; ash pits; special railway tracks required for coal cars, and any other equipment of a similar nature used in connection with the generation of steam.

The subclassification Steam Distributing System (Account No. 3-002-002) includes all charges for pipings and fittings used in distributing steam from the place where it is generated to the point where it is to be used either for the generation of electric

current or for manufacturing purposes. All underground conduits and all mains used for the distribution of steam are chargeable to this classification. In some of the larger manufacturing plants the steam distributing system is further subdivided into high and low-pressure systems. In such instances the low pressure system would consist of that part of the main exhaust line used specifically for distributing exhaust steam for heating purposes.

Items entered against the account Electric Current Generating System (3-002-003) include all charges for generators, dynamos, engines, switchboards and piping, condensers, trenches, suction and delivery mains, special foundations, etc., accessory to the generation of electric current.

The Electric Current Distributing System (Account No. 3-002-004) includes all wiring from the feeder switch terminals in the dynamo room up to and including the controlling apparatus in the various departments where the current is to be used. All special piping outlets and fire protection insulation installed to conform with the requirements of the National Board of Fire Underwriters are also included under this classification.

The Mechanical Transmission System (Account No. 3-002-005) includes all line and jack shafting, fixtures and motors pertaining thereto, pulleys, hangers, switchboards at the local operating points, and any other transmission equipment of like nature. It does not include belting, however, as this is charged to shop expense.

Under the Compressed Air System (Account No.

3-002-006) is included all equipment used for this purpose, such as air compressors, main pipe lines to hose or machine connections, headers, and other items.

The Electric Illuminating System (Account No. 3-002-007) includes all arc lamps, pulleys, incandescent lamp clusters, all wiring from the distributing boards, extension cords, guards, rosettes, stands, reflectors, and so forth.

In a general way this sums up the permanent fixtures chargeable against the various power systems. A segregation of this kind is made for the purpose of determining power costs more accurately than is possible where this equipment is all charged against a single power account. For example, it is important that the factory management know to a fraction of a cent the cost of a thousand pounds of steam generated, the cost of distributing this steam, the cost of a kilowatt hour for all electric current generated and distributed, and the cost of each thousand cubic feet of free air compressed. Since a large part of the costs of producing or distributing power are made up of the charges for depreciation, insurance, and taxes on the equipment used, and also since these charges are obtained on the basis of the face values of the equipment, it will be readily seen that a mistake in classification will produce an error of no mean proportions in the power costs.

Permanent Fixtures Pertaining to Water.—Having considered both permanent fixtures pertaining to buildings and to power plant, let us now analyze briefly the permanent fixtures pertaining to water

and to material. Permanent fixtures pertaining to water (Account No. 3-003) may be arbitrarily divided into the following main headings:

3-003-001—General Supply and Sewer System
3-003-002—Fire Protection System
3-003-003—Internal Water Distributing System
3-003-004—High Pressure Distributing System.

Considering these accounts in the order named, the General Supply and Sewer System (Account No. 3-003-001) would include any water mains, pipe lines, meters, piping and fittings, gravity tanks, pumps, artesian wells, and factory sewerage systems which are not a part of the internal distributing system.

The Fire Protection System (Account No. 3-003-004) would include all fire pumps, gravity tanks reserved for fire use, hydrants and special pipe lines, sprinkler piping, heads and other fittings, and any other appurtenances which are used as safeguards against or for the control of fire.

The Internal Water Distributing System (Account No. 3-003-003) would include special piping, wash bowls, sinks, traps, catch basins, suction and gravity tanks, main internal distributing lines and piping, meters, drinking stations and attachments and any refrigerating equipment used for cooling drinking water.

The High Pressure Water System (Account No. 3-003-004) would be used only by plants that maintain such a system as a part of their manufacturing equipment. This would apply to cases where water under high pressure was needed for testing purposes

or for similar requirements. Where such a system is maintained as part of the fire protection equipment it would then be included under Account No. 3-003-002. But when the system is a necessary adjunct of the manufacturing equipment it would include accumulator and pressure tanks, extra strong pipe lines, fittings, and other devices used in connection with that equipment.

Permanent Fixtures Pertaining to Material.—This account (3-004-001) includes all freight elevators, underground oil tanks, chutes, dry kilns, tanks for combustibles, built-in material scales, and other similar equipment.

Value of Detailed Analysis.—A careful study of the foregoing analysis of the permanent fixtures account may cause the reader to question the necessity of making such a detailed analysis of an apparently unimportant plant account. It is true that such a detailed system of classification may be entirely impracticable in the average small plant, but on the other hand in a treatise of this kind it is necessary to outline a system of classification which will be applicable not only to small plants, but to large and extensive ones as well. It is perfectly obvious that where conditions of manufacturing, size of plant, and class of business do not warrant a detailed analysis of the plant accounts, any unnecessary subclassifications can easily be eliminated. But it is well to remember, however, that very little extra work is required in classifying equipment according to kinds and usage over that required in charging it all to one general classification.

The importance of making such a segregation of accounts will become more and more apparent when it is realized that these capital charges are used as a basis for obtaining the expense loadings to be assessed as a part of the cost of the manufactured product. For example, in discussing permanent fixtures pertaining to power, it was shown that the cost of generating and distributing steam and electric current relied for its accuracy on the proper classification of permanent fixtures pertaining to the power plant according to the respective power systems.

In like manner, permanent fixtures pertaining to buildings become a part of the rent charge, as will be shown later when the subject of rent expense is more fully discussed. Permanent fixtures pertaining to water are chargeable in like manner to conform with their usage. Under this classification all permanent fixtures pertaining to the fire protection system would be chargeable to rent, while those permanent fixtures classified under the high-pressure water system would be directly chargeable to manufacturing through what will later be termed Machine Expense, providing that this system were maintained for testing or for manufacturing purposes. But on the other hand, if the high-pressure water system were used for fire protection, then all charges for depreciation, insurance, and taxes, based on the investment in its permanent fixtures pertaining would be chargeable to rent. In the same way, permanent fixtures pertaining to material would be used as a basis for deriving the depreciation, insurance, and tax charges assessable against material expense. As all indirect expense is

finally charged either to machine expense or to material expense, and these expenses are then charged against individual costs of manufacture on two entirely different bases, it will be seen that the more careful an analysis is made of the original charges to the respective plant accounts the more accurate will be the final cost of any article manufactured.

In trying to grasp the relative significance of this detailed classification arrangement, it will be well to bear in mind that the proper classification of plant accounts has a direct bearing on ultimate costs; and while the discussions may not seem analogous at this point, it will become more and more so as a more detailed study is made of the method of tying in all charges relating to the cost of manufacture, so that the final cost of any and all goods manufactured will include the direct charges for labor and material applied thereto, and also the proper proportion of all the indirect expenses incidental to manufacturing. As these indirect expenses, as explained in the previous chapter, amount, in many cases, to more than the labor and material employed in producing an article, it will be seen that the more detailed the system of classification the more accurate will be the amount of indirect expense chargeable against each article manufactured and, therefore, the more accurate will be the final cost.

CHAPTER III

CLASSIFICATION OF PLANT ACCOUNTS

(*Continued*)

MACHINERY, TOOLS, PATTERNS, SHOP FIXTURES, OFFICE FURNITURE.

Classification of Machinery Account.—Of the plant accounts there still remains to be considered the machinery, tools, patterns, shop fixtures, and office furniture accounts. To Machinery, Account No. 4, are chargeable all standard and miscellaneous types of machinery. The charges made to this account will therefore be classified either as Standard Machinery, Account No. 4-001, or as Miscellaneous Machinery. Account No. 4-002. The following specimen list will give a general idea of the types of machines that would be classified as standard in the metal and textile trades:

Metal Working Shops

4-001-001—Lathes, screw machines
002—Miscellaneous lathe types
003—Milling machines
004—Drill presses
005—Grinders
006—Buffers and polishers
007—Tappers
008—Punch presses
009—Shears

010—Metal planers
011—Mechanical hammers
012—Metal saws
013—Sheet metal rollers and formers
014—Furnaces, forgers, and annealing machines
015—Anvils
016—Jointers and planers
017—Moulders and shapers
018—Sanders
019—Wood saws
020—Morticing and tenoning machines

Textile Mills

4-001-001—Looms
002—Carders
003—Warpers
004—Spinning frames
005—Winders
006—Slashers
007—Napping machines
008—Twisters
009—Mercerizing machines
010—Dyeing and bleaching machines
011—Finishing and pressing machines
012—Quilling machines

Where productive work, such as assembling, is done at benches, they may also be classified under Standard Machinery. This is merely for the purpose of obtaining eventually a bench rate per hour.

Under the second classification, Miscellaneous Machinery (Account No. 4-002) would be charged all miscellaneous or special types of machinery or equipment used directly in a productive capacity. All such non-portable fixtures shown in the following list of subclassifications would be included:

4-002-001—Cranes and Air Hoists (jib and hand swinging cranes and motors, wiring, installation connected therewith, and traveling cranes of small size used for lifting small units, which would probably be moved to a different location after the departments using them were moved.

4-002-002—Tracks, Trolleys and "I"-Beam Runways used for the moving of materials by railways or traveling cranes.

4-002-003—Ovens and Furnaces of all kinds, including non-portable forges, cupolas, japanning ovens and annealing, tempering, and melting furnaces.

4-002-004—Tanks, Pots, Vats, Kettles, Water and Oil Filters, Tempering, Soda, Parafin and Dipping Tanks; Condenser Kettles, Glue Pots, Plating and Dyeing Vats, etc.

4-002-005—Blowers, Motors and Exhaust Fans and Piping; Hoods, Canopies, Floor Gratings and similar equipment used in connection with the miscellaneous machinery under the preceding two classifications.

4-002-006—Foundations for Standard Machinery.

4-002-007—Testing Apparatus.

4-002-008—Any other similar unclassified equipment.

Charges either for standard or for miscellaneous machinery should be further subclassified by departments wherever it is possible to do so. For example, milling machines purchased for the milling department, Department No. 510, would be classified 4-001-003-510; while a japanning oven installed in Department No. 600, the japanning department, would be classified 4-002-003-600.

Commencing with the issuance of the order for new machinery and going through to the time the machine

is installed in the shop, the following should be the successive steps taken in making up the records:

1. Copy of order sent to the Plant Records Department for inspection. A number should then be assigned to the machine and entered on card for "Numbered Machinery," Form 1, and for "Miscellaneous Machinery" on Form 2. All copies of the numbers so assigned are then posted on the original order, which, after being classified, is sent to the Voucher Department for further disposition.

2. Form 3, "Numbered Machinery," and Form 4, "Miscel-

FORM 1

NUMBERED MACHINERY

SHOP NUMBER	ORDER NO.	DESCRIPTION	LOCATION					

FORM 1. NUMBERED MACHINERY CARD

These standard filing cards are 4 by 6 inches, suitably punched to guard against loss.

FORM 2

MISCELLANEOUS MACHINERY

SHOP NUMBER	ORDER NO.	DESCRIPTION	LOCATION					

FORM 2. MISCELLANEOUS MACHINERY CARD

laneous Machinery,'' are then made out, giving information in detail relative to description, number, tool number, location, when installed, etc.

3. Memoranda requesting ''Classification of New Machinery'' is then sent to the Accounting Department, which in turn assigns the correct machine class and advises the Plant Records Department accordingly.

4. Forms 1 and 2 are then filed in numerical sequence.

5. Forms 3 and 4 are filed under heading of ''New Machinery.''

6. Upon notification by the Receiving Department that a machine has been received, the Plant Records Department issues a memorandum to the Millwright Department requesting it to affix a metal tag with the machine number and classification to each of these machines when installed. This memorandum will show

FORM 3

No.	Name Machine	M'f'r's. No.
Made by		At
Bought from		At
Order No.	Bill No.	Date Bill
Description		
Size		

LOCATION				DRIVEN BY	COST		
DATE	SEC.	FLOOR	DEPT.				
					Machine:-		
					Freight:-		
					C't'r. Shaft		
					Total		
					(OVER)		

FORM 3. NUMBERED MACHINERY CARD

Reverse side shows Floor Space, Current required to start, Current required to run, Class of Machine, and Remarks.

FORM 4

No.________ Name Machine ________________

Made by ________________ Size ________

Bought of ________________ Order No. ________

Bill No. ________ Date Bill ________________

Description ________________________

________________________ No. Heads ________

DATE	LOCATION			REMARKS	COST		
	SEC.	FLOOR	DEPT.				
					Machine		
					Freight		

FORM 4. NEW MISCELLANEOUS MACHINERY CARD

the machine number and classification assigned by the Accounting Department. The person handling the plant records of machinery should then follow up this memorandum and see that these plates have been properly affixed.

7. A complete record should then be made in a binder called "Additions to Plant" of the number assigned, manufacturer's name, order number, and estimated cost; this information can then be used in making up the weekly and monthly reports on appropriations and expenditures.

8. At the end of each month, the increase or decrease of a ledger balance on the Machinery Account should be itemized and recorded in detail in an analysis in a binder called "Analysis of Machinery Account." This analysis should show the shop number, description, cost, location, and amounts of all machinery purchased, manufactured, transferred, sold, and junked.

9. From the analysis binder, the costs of machinery added

to the plant during the month should be posted on the cards, Forms 3 and 4, which in turn will be filed under the respective departments until the machinery is located.

10. Transfers of machinery from one department to another should be adjusted monthly through a petty journal, and the respective machine cards should then be transferred in the files to the new department to which they have been so transferred. This applies to all machinery, whether made in the factory or purchased from outside sources.

11. The permanent records of miscellaneous machinery should be written up on a form similar to Form 5, the same form as that used for Building and Permanent Fixtures Records. At the end of the fiscal year the entire Machinery Account should be summarized according to machinery made, purchased, destroyed, or junked—balance at the end of previous year and balance at end of current year, and then incorporated in the annual report of the status of the plant accounts. For insurance purposes, the Machinery Account should also be summarized according to floors and parts of the building as required.

Classification of Tools Account.—Tools, Account No. 5, is chargeable with the cost of all so-called permanent tools. By permanent tools is meant all tools that are estimated to have a service value of more than one year. Under this classification would be included such tools as dies, templets, jigs, milling fixtures, and so on. Tools which have an estimated existence of less than one year, and which are known as perishable tools, are not chargeable to the Tools Account. They include such items as emery wheels, files, hammers, cutters, plating racks, and the like. As these tools would have to be depreciated to their full value in the first year, they are charged directly

FORM 9

RECORD OF UNNUMBERED MISCELLANEOUS MACHINERY, ETC.

Date of Bill	Total Amount of Bill	Reference	DESCRIPTION	AMOUNT	Floor	Section

FORM 5. FOR NUMBERED MISCELLANEOUS MACHINERY, AS WELL AS FOR BUILDINGS AND PERMANENT FIXTURES

to shop expense. Permanent tools need only be subclassified as to kinds or types, and charged against the departments where they are to be used, wherever it is possible to do so. This is done in a manner similar to the method of classifying machinery as explained in the preceding paragraph, whereby the department number is affixed to the classification to denote the production center where they are used. A list of these tools is shown on page 43.

1. A record of all permanent tools on order should be kept on individual cards similar to Form No. 6, and the cards then filed under the heading of Tools Ordered. When the department making the tool gives notification that the job has been finished, the cards are filed under the heading of Tools Finished, where they will remain until the cost of the job is received from the Shop Cost Department. After the cost has been posted, the cards are filed under the department which originally ordered them.

2. The estimated total cost of all tool orders, with the exception of those charged directly on shop order against a particular job, should be entered in the "Additions to Plant" binder, and posted under the respective headings of departments ordering them. At the end of the year, these entries are then summarized according to location and included in the reports on Additions to Plant and appropriations, in the same manner as the machinery statistics were used.

3. After the proper approvals for junking a tool have been received, Form 7, "Junking Tickets" should be forwarded to the Plant Records Depart-

SPECIMEN LIST OF PERMANENT AND PERISHABLE TOOLS

ARBORS

BASKETS (Plating)
Bellows
Bends
Bits, Auger
Blades
Blocks, Riveting
Blow Pipes
Boxes (for use in case hardening furnaces, etc.)
Braces
Brushes (when used as tools)
Buffs
Burners

CALIPERS
Cams
Carborundum
Centers
Chamois Skin
Chasers
Chisels
Chucks
Chucking Fingers
Clamps
Cloth, Emery
Clippers
Collars
Collets
Coppers, Soldering
Counterbores
Counterboxes
Countersinks
Cutters

DIAMOND Pointed Tool
Dies
Dogs, Lathe
Dressers
Drill Boards
Drills
Dusters, Painters
Die Blocks and Core

EMERY

FEED Tubes
Figures
Fixtures, assembling, staking, etc.
Files
Flasks
Flint
Forming Tool
Frames

GAUGES
Glasses, Eye
Gravers

HAMMERS
Handles
Heaters
Holders
Hoods
Hooks, Cotton

JIGS

KNIVES
Knurls

LADLES
Letters

MALLETS
Mandrels
Micrometers
Mills
Moulds

NEEDLES
Nippers

OIL Stones

PAPER, Carborundum
Emery
Sand
Pencils
Plates
Pliers
Posts
Pots
Punches
Punches and Dies

RAMMERS, Sand (Foundry)
Reamers
Rests, Slide
Riddles
Rules

SAWS
Screw Drivers
Scissors
Sieves
Shovels
Spindles
Spools
Spoons
Staking Pins and Punches
Stamps
Stencils

TAPS
Torches, Blow
Trowels,
Tubes, Feed
Tubing, No. 13 Soft Rubber
Tweezers

VISES

WATCHES, Stop
Wheels
Wrenches

FORM 6

TOOL RECORD CARD

Tool No.		Description		
Made by			Maker's No.	Location
Bought of				
P.O.	Date	Cost	Express	
Inst. No.	Date	Cost		
Remarks				Total cost

DATE	ORDER NO.	ADDITIONS		

DEPRECIATION					REPAIRS AND MAINTENANCE			
Date	Face Value	Annual Deprec.	Total Deprec.	Residual Value	Date	Order No.		Amount

FORM 6. FRONT AND BACK OF TOOL RECORD CARD

ment, after receipt of which the tools should then be listed by departments, priced from the tool records, and written off at the end of the month by means of a journal entry. This form is then forwarded to the department in which the tool is located, which, upon

FORM 7

TRACING RECORD	DEPARTMENT CREDIT – TOOLS JUNKED	
ORDER NO.	ORDER NO.	
W. M. NO.	W. M. NO.	
QUANTITY	QUANTITY	
DEFECTS	DEFECTS	
DATE	DATE	ENTERED ON ORDER BY
FROM	FROM	INSPECTOR
ENTERED MATERIAL DEPT. / ENTERED TRACING DEPT	RECORDS OF TOOLS JUNKED MUST BE KEPT SEPARATE FROM RECORDS OF TOOLS REPAIRED AND REGULAR DELIVERIES	
TOOLS JUNKED		

JUNK	TOOLS JUNKED
ORDER NO.	ORDER NO.
W. M. NO.	W. M. NO.
QUANTITY	QUANTITY
DEFECTS	DEFECTS
DATE	DATE
FROM	FROM
INSPECTOR	
THIS PART TO ACCOMPANY MATERIAL TO JUNK DEPT.	THIS PART BE SENT TO THE SHOP COST DEPARTMENT

FORM 7. ORIGINAL AND DUPLICATE OF TOOLS JUNKED

receipt of the form, will forward the tool to the junk department.

4. A record of all tools junked should be kept in the binder marked "Junked Plant." When the tool account is analyzed, the cards for tools so disposed of are removed from the departmental tool record and after being marked "Junked" are filed under that heading.

Classification of Patterns Account.—Patterns, Account No. 6, is chargeable with all patterns owned by the company, and is further subclassified when necessary according to wood patterns (6-001) and metal patterns (6-002). When a further subdivision is required, according to where they are to be used (brass or iron foundry), this can be made in a manner similar to that outlined for the other plant accounts, by simply appending the proper departmental numbers. In the case of loaning patterns to other companies, or borrowing from them, something that is often done, a special account called "Patterns Loaned" should be charged with these patterns as they are received, and credited with them when they are returned.

Classification of Shop-Fixtures Account.—Shop Fixtures, Account No. 7, is chargeable with all such fixtures as are required by the various departments of the shop to assist them in carrying on their particular line of manufacturing. These usually include such tangible unproductive equipment as enumerated in the following list:

7-001—Trucks.
7-002—Portable scales.
7-003—Non-productive benches.
7-004—Racks.
7-005—Ladders.
7-006—Shelving.
7-007—Desks.
7-008—Stools.
7-009—Tables.
7-010—Wheelbarrows.
7-011—Other unclassified fixtures used in the shop proper.

Classification of Office Furniture Account.—Office Furniture, Account No. 8, includes all equipment and appurtenances used within the shop offices. It does not include office furniture used either in the general offices of the company or by the sales department. In such instances, when all of this work is done in the same office a division should be made so that the shop can be charged with whatever furniture or other equipment is actually used in keeping track of the shop work. This would include such equipment as:

7-001—Desks.
7-002—Tables.
7-003—Chairs.
7-004—Filing devices.
7-005—Adding and computing machines.
7-006—Multigraphing equipment.
7-007—Any other unclassified office furniture.

Transfers and Adjustments.—When a plant item is transferred from one location to another, or replaced, the destroyed portion should be written off

and the new portion added to the account affected. This refers especially to cases where special foundations are necessary and it is found impossible or impracticable to move them. The two transactions here mentioned should be handled as a unit, and if the second cost is higher than the first the difference only should be accounted for. Orders covering such transfers and replacements should be marked as such for the information of the Plant Records Department.

When a plant unit is installed with the intention of removing it at a definite time—such as plant for use during the construction of a permanent plant, for the temporary protection of employees, or property other than that under construction, or as a temporary convenience pending the construction of authorized permanent plant—the cost of such installations should be charged to expense. A matter of this kind should, however, be referred to the general management for authorization and approval. When making adjustments either for new plant or plant sold, junked, or transferred, the following accounting procedure should be observed:

1. All plant sold, junked, or transferred from one account to another, should be adjusted by means of journal entries.
2. At the end of each month, journal entries should be made covering all plant items sold or junked during the course of that month as follows:
   A. Debit Accrued Depreciation Account, with the amount of depreciation set aside as a reserve up to the beginning of the current year, and also with the amount of accrued depreciation for that portion of the current year up to the end of the fiscal month preceding the date on which the junking or sale of

the equipment took place. Credit the proper plant account with the total of this depreciation.

B. Debit Shop Expense and credit Plant Account with the loss. In the case of a profit, this entry should be reversed. The loss equals the difference between the face value less all depreciation (reserve and accrued)—or the net value and the selling price or junk value. Loss equals (F-D-A)—(S or J), when the selling or junk value is less than the net value. Profit equals P equals (S or J)—(F-D-A), when the selling or junk value is more than the net value.

3. At the end of the fiscal year, the total amount debited to Accrued Depreciation during the year should be transferred to the Depreciation Reserve Account. No debits or credits should be made to the Depreciation Reserve Account until the end of the fiscal year.

4. The following form shows how a record of plant items sold or junked can be kept, and a similar but separate record of plant transfer to some other plant of the company should be kept in like manner:

Bill or Order No.	Plant Item		Face Value F	Depreciation		Sale S	Junk J	Profit P	Loss L
	No.	Description		Reserve D	Accrued A				

5. When transfers of plant and equipment are made between different shops of the same company, and when the depreciation amounts to less than 100 per cent, the forwarding shop should render a bill at net valuation showing also face value, depreciation reserves, and accrued depreciation. This bill is then charged at the receiving shop to the proper plant account. Journal Entries of each are made at both the forwarding and

receiving shops at the end of the same month, adjusting the depreciation. All plant depreciated at 100 per cent which was made or bought before the beginning of the current year should be transferred from one shop to another at "No Charge," but the bill should show the face value and depreciation reserve the same as when an actual billing takes place. Any plant equipment made or bought subsequent to the preceding fiscal year should be billed at full value with no adjustment for depreciation.

6. Any transfers of plant that are made between manufacturing departments and any other departments of the company because of changes in organization or for similar reasons, should be handled in exactly the same manner as the transfers between the different shops of the company. No profit or loss should appear in the accounts of either department as the result of such transfers.

7. The annual report and corresponding determination of the amount of depreciation which shall be added to the reserve written off from plant accounts, shall be along the following lines:

Description	Face Value	Per cent depreciation	Direct depreciation at the rates given	Deduct unaccrued depreciation on new plant	Add transferred reserve on plant purchased	Deduct reserve on plant sold or junked	Amount written off during			Per cent total reserve to face value
							Past year	Former year	Total reserve	

This concludes the analysis of what are commonly known as plant accounts. The object has been to draw a clean-cut line of distinction between the accounts in order that this scheme may be followed even

where changes may have to be made to meet the existing conditions. In the average factory, however, this method of division can be applied without making very many changes, by simply inserting the specific kinds of equipment used in each case. It is always good practice to number all equipment whenever it is possible to do so and to keep a card record that can be used for reference or tabulation purposes. It should be thoroughly understood that adjustments to these accounts should be made only when material is added or disposed of. Depreciation written off from any of this plant equipment should never be credited to these accounts themselves, but should be debited, as stated heretofore, to Shop Expense and credited to an account called "Depreciation Reserve." Thus the plant accounts will always show the original worth of all plant equipment, and in the event of any change of policy being made with regard to setting aside reserves for depreciation at any time, this can be done through the depreciation-reserve account without changing the condition of the plant accounts themselves.

Departmental Numbers.—In view of the fact that considerable reference has been made to departmental numbers in connection with analyzing the respective accounts, it might be well to consider at this point the method of assigning such department numbers with a view towards making idenification easy with respect to both location and routing purposes. Each part of the shop organization that receives material, correspondence, or other papers which may be referred to in records to any considerable extent, should be as-

signed a permanent number, as has been done in the classification of machines, tools, and the like. These numbers should be known as department reference numbers and should be used to designate a particular unit of the shop organization whenever used. If these numbers are assigned according to special series which would in turn denote certain general as well as individual parts of the organization, a scheme of this kind would tend towards simplifying the establishment of uniformity in all references to such departments or branches of the shop, simplifying the design of stationery forms and the clerical work involved in the making and handling of records, and also the maintenance of such records in connection with the distribution of material and correspondence in other forms.

This will be found to be of particular use in the writing of time-tickets, requisitions, and payroll classifications, and in the dispatch of orders or materials. When this system is adopted, these departmental numbers are used in preference to the old department names, and it has been my experience that after a continued use of such numbers for a reasonable period of time, they become automatically associated in the minds of those who have occasion to use them, with those specific departments or units of the organization that they designate. In order to give a practical illustration of this method of departmental classification, on the pages which follow I am showing an example taken from actual experience:

SHOP DEPARTMENTAL PERSONAL AND REFERENCE NUMBERS
of the
JOHN SMITH MANUFACTURING COMPANY

DEPT. NO.	DEPARTMENT NAME	LOCATION*	UNDER DIRECT SUPERVISION OF	REPORTING TO
1000	General Supt.	B-1		President
600	Chief Inspector	A-1		1000
900	Production Eng.	A-1		1000
500	General Foreman	A-1		1000
100	*Shop Accounting, Scheduling and Routing Branch.*			
	Accounting Division			900
101	Shop Cost Dept.	A-1		900
102	Voucher and Purch. Dept.	A-1		900
103	Shop Payroll Dept.	B-1		900
104	Shop Messenger Dept.	B-1		900
105	Employment Dept.	B-1		900
106	Stenographic Dept.	B-1		900
107	Foreman's Clerks Dept.	A-1		900
108	Bookkeeping Dept.	B-1		900
109	Piecework Rates Dept.			900
110	Manufacturing Exp. Dept.	A-1		900
111	Special Studies Dept.	A-1		900
	Scheduling and Routing Division			900
201	Shop Order Dept.	B-1		200
202	Shop Output Dept.	B-1		200
203	Shop Stores Dept.	B-1		200
204	Receiving Dept.	C-Base		203
205	Material Order Dept.	B-1		203

*The location of factory departments refers to the section and floor of the building.

DEPT. NO.	DEPARTMENT NAME	LOCATION*	UNDER DIRECT SUPERVISION OF	REPORTING TO
300	*Service and Maintenance Branch*			1000
301	Factory Engineering Dept.	B-1		300
302	Steam and Electric Gen. Plant .	B-1		300
303	House Carpenter's Dept.	B-2		300
304	Millwright Dept.	B-2		300
305	Factory Service Dept.			300
400	*Mechanical Branch.*			
401	Master Mechanic Dept.	B-1		1000
402	Metal Pattern Dept.	D-1		401
403	Wood Pattern Dept.	B-2		401
404	Tool-Making Dept.	B-1		405
405	Tool-Draughting Dept.	A-1		401
406	Chemical Lab. Dept.	B-1		401
500	*Manufacturing Branch*			1000
	Machine Division.			
501	Punch Press Dept.	C-1		500
502	Milling, Drilling and Tapping Dept.	C-1		500
503	Turret Lathe Dept.	B-3		500
504	Valve Dept.	B-2		500
505	Nozzle Dept.	A-2		500
506	Locomotive Dept.	A-3		500
507	Squaring Mach. Dept.	A-3		500
508	Fox Lathe Dept.	C-2		500
509	Speed Lathe Dept.	A-3		500

DEPT. NO.	DEPARTMENT NAME	LOCATION*	UNDER DIRECT SUPERVISION OF	REPORTING TO
	Assembly Division.			
521	Oiler Assembly Dept.	B-3		500
522	Injector Asbly. Dept.	C-1		500
523	Lub. Assembly Dept.	C-4		500
524	Loco. Fitgs. Assembly Dept.	C-4		500
525	Valve Assembly Dept.	B-4		500
	Finishing Division.			
531	Plating and Dipp. Dept.	A-4		500
532	Polishing and Buff. Dept.	A-4		500
533	Jap., Lacq. and Paint Dept	A-2		500
	Special Division.			
541	Brass Foundry	E-1		500
542	Core Room Sec.	B-2		541
543	Moulding Sec.	E-1		541
544	Melting Sec.	E-1		541
545	Filing, Grinding and Sort. Sec.	E-1		541
	Inspection Branch.			
601	Raw Material Insp.	E-Base		
602	Process Material Insp.	F		
603	Final Insp.	F		
604	Tool Insp.	F		
	List of Shop Storerooms.			
251	Raw Material	E-Base		203
252	Raw Material	C-Base		203

DEPT. NO.	DEPARTMENT NAME	LOCATION*	UNDER DIRECT SUPERVISION OF	REPORTING TO
253	Raw Material	A-Base		203
254	Worked and Finished Material	C-Base		203
255	Oiler Stock-Room	B-4		254
256	Pattern Vault	B-1		541
257	Tool Stock-Room	C-Base		405
258	Tool Stock-Room	B-3		405
259	Tool Store-Room	B-2		405

The System of Numbering.—A study of the foregoing arrangement of executive and department numbers will show that these have been assigned according to a definite plan. For example, the factory organization has first been split up into the executive, accounting, scheduling and routing, service and maintenance, mechanical, and manufacturing branches. To these respective branches have been assigned numbers arranged in series of hundreds, each block of 100 being assigned to a different branch or division of a branch.

In accordance with this plan, the accounting, scheduling, and routing branch has been assigned numbers from 100 to 299 inclusive, of which the numbers ranging from 100 to 199 are used to designate the accounting division of this branch and numbers from 200 to 299 the scheduling and routing division of this same branch. The service and maintenance branch is numbered from 300 to 399, the mechanical branch from 400 to 499, the manufacturing branch from 500 to 599. The very fact that a department is numbered

in the five hundreds would therefore immediately designate it as a manufacturing department, whereas any number in the three hundreds would denote a service and maintenance department.

Further subdivisions can then be made to designate parts of any branch, as was done in the specimen list, in the manufacturing branch. Here it will be seen that the manufacturing branch is divided into the "machine," "assembly," "finishing," and "special" divisions respectively, and each of these divisions includes a number of different departments. For example, all departments included as part of the machine division are numbered from 500 to 520, while departments in the assembly division are numbered from 521 to 530, the finishing division 531 to 540, and the special division from 541 to 550. Therefore a department that had a number between 500 and 520 would immediately be known as one of the machine departments, while in the same way a department having a number between 521 and 530 would be known as one of the assembly departments.

The advantages to be derived from a system by which departments are numbered in a manner similar to that which has just been outlined, is more or less self-evident and does not require any further analysis. It is enough to say that a system of this kind expedites all matters incidental to manufacturing routine, and establishes a greater degree of uniformity than any other arrangement can possibly do. A reference list of this kind can be drawn up in a very few minutes and, as has already been stated, the various units of the factory will soon become known

by these numbers instead of by their old departmental names. Another advantage to be derived from this method is found when classifying charges against the respective departments or divisions of the shop organization.

Comprehensive Plan Essential.—Any system of cost accounting for a manufacturing business is dependent for its success in operation on a comprehensive plan of classification of all charges incurred in manufacturing. Without such a plan as a basis, it is practically impossible to determine the exact cost of any article produced by the factory organization. I have gone into this matter in considerable detail in the preceding pages mainly with the object of impressing the reader with the importance of this question of classification and with its bearing on the whole scheme of cost accounting. It should be thoroughly understood that a simple reading of this chapter will not have the desired effect that I have in mind. On the other hand, a careful study will reveal the fact that this material has been presented with the purpose of establishing a basis of classification rather than to show the use of the specific material outlined. The various ramifications which will come to the reader's mind in connection with this subject will help him in establishing the principle herein outlined so as to make it conform to any specific case.

CHAPTER IV

FUNCTIONS OF CONTROLLING AND SUBSIDIARY LEDGER ACCOUNTS—

Journal Entries

Purpose of the Accounts.—The accounts of a manufacturing business may be arbitrarily divided into two distinct classes: "Controlling" and "Subsidiary" Accounts. The primary object of both these classes of accounts is to show the operations of the company either as a whole or according to any of its parts. The controlling accounts which are carried on the general ledger, are intended to show the operations of the company for any period and also, through a comparison of the assets and liabilities, the status or worth of the business at any time. They are further intended to show the investment of the company in property owned or held in its name, the purchases, sales, and transfers of merchandise, and the volume and cost of producing the manufactured product, as well as to record the expenses of conducting the business in its administrative, purchasing, selling, and stock-keeping phases—all with the object of ascertaining its degree of profitableness.

Function of the Subsidiary Ledger.—In the preceding chapter a method of classifying the charges that enter into manufacturing was outlined. It was found that by means of such a system of classification all items, whether pertaining to purchases, sales, ex-

pense, or costs of manufacture, can be allocated so that they can be used in combination with one another through entries made in the subsidiary ledger and so that they will reflect the workings of the different departments or separate units of the company. The function of the subsidiary ledger is to show, through its accounts, a finer segregation of any of the charges included in any of these divisions than would be possible were these all entered as part of the main or controlling accounts on the general ledger. It will therefore be seen that while the function of the subsidiary ledger is purely analytical, it nevertheless fulfils a necessary want because combinations of charges pertaining to manufacturing can be arranged in any way most desirable so as to reflect the status of the different subdivisions of the business. This could not be done in a practical manner through the controlling accounts on the general ledger.

General Grouping of Accounts.—The General Ledger Accounts of a manufacturing business may be arbitrarily divided into the following groups, each of which is composed of a number of separate accounts:

A. Factory Plant.
B. Warehouses, Sales Rooms, and Offices
C. Other Real Estate.
D. Raw Materials and Work in Process.
E. Merchandise.
F. Expense (other than Shop)
G. Other Income.
H. Cash.
I. Receivables.

J. Payables.
K. Capital.
L. Depreciation.
M. Patents.

The following is a list of these separate accounts as included in the respective groups listed above. They are all general ledger accounts:

(A) Factory Plants:

Account No. 1 Grounds.
" " 2 Buildings.
" " 3 Permanent Fixtures.
" " 4 Machinery.
" " 5 Tools.
" " 6 Patterns.
" " 7 Shop Fixtures.
" " 8 Office Furniture.

(B) Warehouses, Sales Rooms, and Offices:

Account No. 9 Grounds.
" " 10 Buildings.
" " 11 Permanent Fixtures.
" " 12 Warehouse Fixtures.
" " 13 Office Furniture.
" " 14 Transportation Equipment.

(C) Other Real Estate:

Account No. 15 Grounds.
" " 16 Buildings.
" " 17 Permanent Fixtures.

(D) Raw Materials and Work in Process:

Account No. 18 Shop Productive Labor.
" " 19 Shop Raw Materials.
" " 20 Shop Expense.
" " 21 Shop Finished Goods.

"	"	22	Shop Goods in Process.
"	"	23	Shop Output.
"	"	24	Shop Scrap.

(E) Merchandise:

Account	No.	25	Merchandise (Company Manufacture).
"	"	26	Merchandise (Not Company Manufacture).

(F) Expense (Other than Shop):

Account	No.	27	Engineering Expense.
"	"	28	Trading Expense.
"	"	29	General Expense.
"	"	30	Bad Accounts.
"	"	31	Interest.

(G) Other Income:

Account	No.	32	Real Estate Income and Expense.
"	"	33	Interest (Income).

(H) Cash:

(Account No. 34).

(I) Receivables:

Account	No.	35	Bills Receivable.
"	"	36	Accounts Receivable.

(J) Payables:

Account	No.	37	Mortgages and Bonds payable.
"	"	38	Accounts Payable.
"	"	39	Bills Payable.
"	"	40	Accrued Depreciation.
"	"	41	Accrued Insurance.
"	"	42	Accrued Taxes.

(K) Capital:

Account No.	43	Capital Stock (Authorized).
" "	44	Capital Stock (Issued).
" "	45	Investment.
" "	46	Reserves.
" "	47	Surplus.
" "	48	Profit and Loss.

(L) Depreciation:

Account No.	49	Depreciation of Factory Plant.
" "	50	Depreciation of Warehouses, Sales Rooms, and Offices.
" "	51	Depreciation of Merchandise
" "	52	Depreciation of Patents.

(M) Patents:

Account No. 53

Of the thirteen main groups of accounts pertaining to a manufacturing business, as outlined above, there are only four which have to do directly with manufacturing—such as would be included in what might be called the "Shop" part of the business. These are the Factory Plant (Group A), Raw Materials and Work in Process (Group D), Merchandise Manufactured (Group E), and Depreciation (Group L). In view of the fact that we are especially interested at this point in the relationship and functions of those accounts that pertain directly to manufacturing, let us consider these four groups of accounts in the order in which they have been named.

Raw-Material and Work-in-Process Accounts.—The Factory Plant Accounts (Group A), do not need any further analysis, as these have been sufficiently ana-

lyzed in the preceding chapter. Group D, which includes the Raw Materials and Work in Process Accounts, is the one most used in connection with cost accounting. The first account listed under this group is the Productive Labor Account, to which is charged each month the cost of all labor that is directly applied to production orders. This account should not be charged with any indirect labor expense, such as might be incurred through wages paid to sweepers and cleaners, porters and men making repairs. It should include only the cost of the labor that is directly employed in increasing the value of product in process of manufacture. Even in the latter case, it should not include any idle time of productive workers who may be temporarily disengaged through power being cut off, waiting for work from another department, break-downs, and so on.

All labor which is not productive in the sense herein outlined is known as "Indirect" or "Non-Productive Labor"; it should be charged to the Shop Expense Account, and not to the Productive Labor Account. While all labor employed in any way in connection with producing the manufactured product is productive in the true sense of the word, the term "Non-Productive" as here applied to labor other than that directly engaged in producing, is used simply to differentiate between the two classes, and should therefore not be interpreted in a strictly literal manner.

Raw-Material Account.—The Shop Raw Materials Account is charged each month with the cost of raw materials purchased for manufacturing use. The term "raw materials" as here used does not include

expense supplies such as oils, waste, cleaning compounds, and other materials or supplies of like nature which are not used to enhance directly the value of the manufactured product. All such supplies and materials are considered in the same category as the non-productive labor referred to in the preceding paragraph, and in like manner are chargeable to the Shop Expense Account.

Shop-Expense Account.—The Shop Expense Account is charged each month with the current manufacturing expense of the business other than productive labor and raw materials. It includes all such indirect labor, expense, materials, and supplies as have been referred to in the two preceding paragraphs, and all charges for administration, power, rent, depreciation, insurance, taxes, and so on which are properly assessable against the shop part of the company organization. Shop Finished Goods and Shop Goods in Process Accounts are credited, and the Shop Output Account debited, monthly with the sum of the shop productive labor, raw materials, and shop expense which have been applied on the manufactured product for that period. This sum is obtained by summarizing the job cost-summary sheets that have been figured during the month by the cost department. The method of journalizing these entries and carrying them through to the Merchandise Account will be explained more fully in succeeding paragraphs of this chapter.

Shop-Scrap Account.—The Shop Scrap Account is designed to assist in determining the expense incurred throughout the year in handling and disposing

of shop scrap material. The account is charged monthly with the estimated value of the scrap material sent to the scrap room for disposition, and is credited with the amount received from the sale of this material. All expense incurred in handling and disposing of scrap material is chargeable to this account monthly.

This expense includes all labor expended in converting scrap into some shape or form which will tend to increase its value; the labor expended in sorting, weighing, pressing and boxing this material for shipment; the cost of supplies, including rope, boxes, barrels and other material, used in packing; the cost of burning non-redeemable waste, and the current operating expenses of the scrap room, such as power, rent, light, insurance, taxes, administration expense, and depreciation of equipment. The balance to this account at the close of the year is indicative of a profit or a loss on shop scrap, and is closed out by charging the Shop Raw Materials Account with the loss sustained in disposing of the scrap material during the year, and crediting the Shop Scrap Account. In case of a profit, this entry would be reversed.

Journal Entries.—In making journal entries, it is always good policy to adopt, whenever possible, a uniform system whereby the same kind of entries are made each month throughout the year. This can be done by simply assigning a definite number to each entry that is so made. For example, in the preceding paragraphs it was found that an entry was made each month debiting the Shop Output Account and crediting the Shop Deliveries and Goods in Process Ac-

counts with the amount of productive labor, raw material, and shop expense applied to the manufactured product for that period. Assuming, therefore, that this was Entry No. 10 the first month, it would thereafter always be assigned the same journal entry number for all succeeding months. In like manner, any other entry made each month could be assigned a specific journal-entry number and would thereafter always be given this same number.

This method makes possible a very easy reference in cases where it is desirable to refer back to different entries made throughout the year, for the accountant would automatically refer to Journal Entry No. 10 or any other journal entry number that had been standardized. Such a system does away with the necessity of scanning all entries until the one which is needed is found. Along this same line, it simplifies matters to start numbering all entries each month at No. 1 and assigning consecutive numbers until all the entries have been made. Under this arrangement, if there were fifteen standard journal entries, the first special entry to be made would be number 16, the second 17, and so on, until all the journal entries had been made.

The method also provides a means by which the accountant may easily make sure that all the standard entries have been made, since in such a case as the one mentioned above an omission of any number from one to fifteen inclusive would immediately signal the fact that this standard entry had somehow or other been omitted. The principal importance of this method of numbering journal entries is that it makes

the work of the accountant somewhat easier from both a posting and an analytical standpoint, and at the same time establishes a certain degree of uniformity in the system of making the postings to the general ledger.

Shop-Cost Elements.—In order to convey a comprehensive idea in regard to the method of making these journal entries to the various controlling cost accounts, let us assume, for example, that an expenditure of $24,000 had been made during the year for productive labor, raw material and shop expense, and that these items had been entered to the respective ledger accounts through the following specimen entry, which shows the net totals for all the entries made during the year to these accounts:

Journal Entry No. 1.

	Dr.	Cr.
Productive Labor........................	$5,000	
Raw Material............................	10,000	
Shop Expense............................	9,000	
Cash		$24,000

We shall assume for the purpose of illustration that the shop costs have been summarized once a month and entered to the different accounts that will be shown herewith. It should be especially kept in mind at this point that while these costs for work done are made up of three elements—productive labor, raw material, and shop expense—only two of these are definite quantities, namely, productive labor and raw material. Shop Expense, being more or less intangible,

is added by means of a predetermined standard loading-rate, which has been established on the basis of past experience.

It will therefore stand to reason that this introduces a variable quantity, the accuracy of which it will hardly be possible to ascertain much before the close of the year. This is due mainly to the fact that certain expenditures, such as repairs or renewals in connection with plant, may be made at certain periods of the year and, unless these charges are spread over the entire period, it would not give a fair basis of cost comparison at the end of any month with preceding periods.

Shop-Cost Differences.—In view of this variable quantity of shop expense, therefore, and also because of other variables which may be due to errors in computing costs or in pricing materials, a difference will invariably exist between the totals for productive labor, raw material, and shop expense as taken from the individual cost sheets which have been summarized for the month, and the charges for productive labor, raw material, and shop expense which have been entered to these respective ledger accounts during the same month.

Let us assume, therefore, that at the end of each month an account called "Shop Finished Goods" has been credited with the cost of the completely manufactured merchandise for that period. Let us suppose, too, that an account called "Shop Goods in Process" has also been credited with the cost of all other work in process, such as completed parts or partially finished goods, which in themselves do not

comprise a marketable piece of merchandise or apparatus, and which have to be either assembled with other parts or have some other work done on them before they can be sold.

We shall assume for example, that the amount of finished goods for the year has amounted to $18,000, that the net amount of goods in process at the end of the year amounts to $4,000, and that these comprise the net credits of entries made to these accounts throughout the year. The offsetting debit for $22,000 is charged to an account called "Shop Output" These entries would have been made as follows:

JOURNAL ENTRY No. 2.

	Dr.	Cr.
Shop Output Account....................	$22,000	
Shop Deliveries Account..................		$18,000
Shop Goods in Process Account...........		4,000

Function of Shop-Output Account.—The Shop-Output Account, to which this offsetting debit entry is made, is designed primarily for the purpose of reflecting the efficiency of the shop as nearly as it is possible to determine it by a comparison of the current costs of manufacture with those of previous periods. It also serves the purpose of showing the total investment of the company in finished goods and work in process at any time. This comparison of current costs, as above referred to, is made by crediting the Shop Output Account each month, as shown by journal entry No. 3, with the cost of all goods manufactured as based on a predetermined standard cost. This cost has been arrived at through a study of past ex-

perience, and is the basis on which the company is at that time fixing its selling prices. It is intended to be neither a high nor a low figure, but a fair average of past costs, which can be used as a basis for establishing these selling prices.

Therefore, if the Shop Output Account is credited with $21,000, which we shall assume to be the predetermined standard cost of all goods manufactured during the current year, and debiting the Merchandise, (Company Manufacture) Account with this same amount, the Shop Output Account will have a charge on the debit side of $22,000. This will be the computed cost of the current year's product as compared with the credit of $21,000 to the same account, which represents the cost on which the company is basing its selling prices. In other words, it would seem to indicate that the manufacturing efficiency was falling off, providing that all of the other factors were the same. This entry would have been made as follows:

JOURNAL ENTRY NO. 3.

	DR.	CR.
Merchandise (Company Mfr.) Account....	$21,000	
Shop Output..............................		$21,000

Because of the difficulty of arriving at the predetermined cost of piece parts which have not been entirely completed at the end of any month, the actual cost of all such parts for the current month should be used. As the figures that have been used above represent the net totals of all entries which have been made to these accounts during the current year, then

at the end of the year before finally closing the books, the status of these accounts would be as follows:

CASH

Dr.	Cr.
	$24,000 (J. E.-1)

PRODUCTIVE LABOR

Dr.	Cr.
(J. E.-1) $5,000	

RAW MATERIAL

Dr.	Cr.
(J. E.-1) $10,000	

SHOP EXPENSE

Dr.	Cr.
(J. E.-1) $9,000	

FINISHED GOODS

Dr.	Cr.
	$18,000 (J. E.-2)

SHOP GOODS IN PROCESS

Dr.	Cr.
	$4,000 (J. E.-2)

SHOP OUTPUT

Dr.	Cr.
(J. E.-2) $22,000	$21,000 (J. E.-3)

MERCHANDISE (COMPANY MFR.)

Dr.	Cr.
(J. E.-3) $21,000	

Adjusting Shop-Cost Differences.—An inspection of the above accounts will show that the sum of the balances to the Productive Labor, Raw Material, and Shop Expense Accounts respectively, is a debit of $24,000; while the sum of the balances to the Finished Goods and Shop Goods in Process Accounts shows a credit of only $22,000. This difference of $2,000 therefore represents errors made during the year in computing the individual costs, for the reason that if

these had all been properly compiled, they should have equalled the sum of $24,000, which has been expended in manufacturing during the year. This error, however, is not necessarily clerical—although it may be such—but is in all probability due to a difference between the actual shop expense for the year as charged to that account, and the estimated expense which has been used as a basis for applying the "shop expense loading" to individual costs of manufacture throughout the year. It is now necessary, accordingly, to adjust the Finished Goods and Goods in Process Accounts so that the sum of the two will equal the total of $24,000. This is done by pro-rating the difference of $2,000 on the basis of the net balances to these two accounts, and then crediting them with their proportionate share of the difference and debiting the Shop Output Acccount with the total of $2,000, as shown by the following entry:

JOURNAL ENTRY No. 4.

	Dr.	Cr.
Shop Output Account....................	$2,000	
Finished Goods Account (18/22 of $2,000).		$1,636
Finished Goods in Process Account (4/22 of $2,000)		364

The status of all of these cost accounts would then be the following:

CASH

Dr.	Cr.
	$24,000 (J. E.-1)

PRODUCTIVE LABOR

Dr.	Cr.
(J. E.-1) $5,000	

RAW MATERIAL

Dr.	Cr.
(J. E.-1) $10,000	

SHOP EXPENSE

Dr.	Cr.
(J. E.-1) $9,000	

FINISHED GOODS

Dr.	Cr.
	$18,000 (J. E.-2)
	1,636 (J. E.-4)
Bal.	$19,636

SHOP GOODS IN PROCESS

Dr.	Cr.
	$4,000 (J. E.-2)
	364 (J. E.-4)
Bal.	$4,364

SHOP OUTPUT

Dr.	Cr.
(J. E.-2) $22,000	$21,000 (J. E.-3)
(J. E.-4) 2,000	
Bal. $3,000	

MERCHANDISE (COMPANY MFR.)

Dr.	Cr.
(J. E.-3) $21,000	

Cost Accounts in Balance.—The credit balances to the Finished Goods and Shop Goods in Process Accounts, as shown above, now equal the debit balances to the Productive Labor, Raw Material, and Shop Expense Accounts, respectively, therefore the sums of both groups are equal. The Shop Output Ascount shows a debit balance of $3,000, which represents the excess cost of producing the manufactured product during the current year, as compared with preceding periods on which was based the predetermined standard cost used to make the entry of $21,000

on the credit side of this same account. The debit balance to this Shop Output Account of $3,000, and the debit balance to the Merchandise (Company Manufacture) Account of $21,000, are offset by the credit balance of $24,000 to the Cash Account.

Closing Cost Entries.—In order to close the books for the year, the following entry would then be made:

JOURNAL ENTRY NO. 5.

	DR.	CR.
Finished Goods Account....................	$19,636	
Finished Goods in Process Accounts.......	4,364	
Productive Labor Account................		$5,000
Raw Material Labor Account.............		10,000
Shop Expense Labor Account.............		9,000

These accounts would then appear in this form:

PRODUCTIVE LABOR

Dr.		*Cr.*	
(J. E.-1)	$5,000	$5,000	(J. E.-5)
Bal.	000		

RAW MATERIAL

Dr.		*Cr.*	
(J. E.-1)	$10,000	$10,000	(J. E.-5)
Bal.	000		

SHOP EXPENSE

Dr.		*Cr.*	
(J. E.-1)	$9,000	$9,000	(J. E.-5)
Bal.	000		

FINISHED GOODS

Dr.		*Cr.*	
(J. E.-5)	$19,636	$18,000	(J. E.-2)
		1,636	(J. E.-4)
Bal.	000		

SHOP GOODS IN PROCESS

Dr.		Cr.	
(J. E.-5)	$4,364	$4,000	(J. E.-3)
		364	(J. E.-4)
Bal.	000		

This leaves only the Shop Output Account to be closed into the Merchandise (Company Manufacture) Account, which is done through the following entry:

JOURNAL ENTRY NO. 6.

	DR.	CR.
Merchandise (Company Manufacture) Account	$3,000	
Shop Output Account....................		$3,000

The status of these accounts would then be this:

SHOP OUTPUT

Dr.		Cr.	
(J. E.-2)	$22,000	$21,000	(J. E.-3)
(J. E.-4)	2,000	3,000	(J. E.-6)
Bal.	000		

MERCHANDISE (COMPANY MFR.)

Dr.		Cr.
(J. E.-3)	$21,000	
(J. E.-6)	3,000	
Bal.	$24,000	

Having closed out all of these ledger accounts except "cash," into the Merchandise Account, we now have a debit balance of $24,000 to this account, which represents the cost of manufacturing for the current year. The offsetting credit for this same amount is the balance shown by the Cash Account:

MERCHANDISE (COMPANY MFR.)

Dr.	*Cr.*
(J. E.-3) $21,000 (J. E.-6) 3,000	
Bal. $24,000	

CASH

Dr.	*Cr.*
	$24,000 (J. E.-1)
	Bal. $24,000

Monthly Adjustment for Finished Goods Previously Charged to Process Goods.—Monthly transfers should be made between the Shop Goods in Process Account and the Finished Goods Account for merchandise which has previously been credited to the Shop Goods in Process Account because of its being incomplete at the time when the previous entries were made, but which has in the meantime been converted into finished merchandise. This transfer is made by debiting the Shop Goods in Process Account and by crediting the Finished Goods Account each month with such goods.

Shop Output Account as Guide for Management.—I have endeavored to show in the foregoing sequence of entries the purposes of the various controlling accounts pertaining to cost finding, and also the possibilities of using such of these as the Shop Output Account as a means of comparing the current output cost with that of preceding periods. While the balance to the Shop Output Account in the illustration here used represents a shop loss, so to speak, it could, on the other hand, under different conditions show a shop profit. Whatever the balance may be, however, it will serve to act as a guide for the man-

agement in checking its selling prices and in controlling the operations of the production end of the business.

From a management point of view, it is of vital importance to know whether the shop is producing on an efficient basis, and also what the cost of production for any period bears to that of other periods. There is no better way of reflecting the status of shop efficiency, provided conditions do not materially change, than by means of ledger accounts of this kind. Strictly speaking, the "shop" part of a manufacturing organization cannot either make a profit or sustain a loss. These terms as herein used, therefore, are simply indicative of costs greater or less than those on which selling prices are based.

This shop profit or loss might be incurred through more or less efficient shop administration, variations in the activity of the shop due to idle capacity or possible overtime, expenditures not controlled by the shop management—such as fluctuations in the cost of labor, materials, and so on—extensive repairs and changes throughout the plant, accidents, general changes in methods of manufacture, or as a result of any other similar causes which might bring about variations in the costs of manufacture from year to year.

Purpose of Cost Systems.—It should be distinctly kept in mind that the ultimate purpose of a cost system is to assist the management in running its plant on an economical basis. Therefore, any means devised that will act as a measure of the difference between the current and the standard costs of production, will serve as a guide for the management in exercising the

proper control and providing remedies wherever necessary.

The trouble with most cost systems is that those who devise them resort to a multiplicity of accounts which are carried as controlling accounts on the general ledger, and which tend more to befog the whole issue than to clear it up. Therefore, the compiling of a mass of incomprehensible data which, when completed, mean nothing to the management, is equivalent to just so much wasted effort. Where this fact is lost sight of, the cry of "too much system" is immediately raised—and justly so.

Analyzing General Ledger Charges in Subsidiary Ledger.—While the Shop Output Account simply shows the comparison between the totals of predetermined and computed current costs of the shop output, these same comparisons for different classes of merchandise can be made in the same way from an inspection of the subsidiary ledger. It will be remembered that I have constantly referred to the importance of sub-classifying all controlling ledger accounts whenever possible and showing this analysis according to these classifications on the subsidiary ledger. Therefore, in making an entry to an account such as the Shop Output Account, the journal entry should also show the sub-classifications according to the various kinds of merchandise. Since these would then be posted to the subsidiary ledger, comparisons can be easily made between the predetermined standard and the computed current year costs at any time, and any abnormal variations can then be immediately investigated.

Comparison of Current and Predetermined Costs.—The following journal entries, which are duplicates of Journal Entries No. 2 and No. 3, show the debit and credit entries, respectively, to the Shop Output Account, sub-classified according to kinds of merchandise manufactured. The specimen subsidiary ledger accounts which follow these journal entries show how these comparisons for different classes of merchandise manufactured can be made. An inspection of these subsidiary ledger accounts will show that where the balance is a credit the goods have been manufactured at less than the standard predetermined cost, while those that show a debit balance indicate that it is costing more to manufacture these respective classes of merchandise than was the case in preceding years.

JOURNAL ENTRY NO. 2.

	DR.	CR.
Shop Output Account....................	$22,000	
Finished Goods Account..................		$18,000
Finished Goods in Process Account........		4,000

Subclassifying this entry according to the kinds of merchandise, we find it is made up as follows:

001	$5,400
002	4,000
003	3,600
004	5,500
005	3,500
Total	$22,000

On the same page of the journal entry would appear the following explanation: "Debiting Shop Output Account with current year costs of Finished Goods and Work in Process, as computed during year."

JOURNAL ENTRY NO. 3.

	Dr.	Cr.
Mdse. (Co. Mfr.) Account................	$21,000	
Shop Output Account..................		$21,000

Subclassifications show that this entry is composed as follows:

001—(Valves)	$5,600
002—(Fittings)	4,450
003—(Grease Cups)....................	2,700
004—(Gauges)	4,350
005—(Sundries)	3,900
Total	$21,000

And on this page the explanatory statement would appear: "Crediting Shop Output Account with mdse. manufactured during year as figured on basis of Predetermined Standard Costs."

From the two journal entries Shop Output Subsidiary Ledger Accounts would be made up as follows:

SUB-CLASS .001

Dr.		*Cr.*	
(J. E.-2)	$5,400	$5,600	(J. E.-3)
Bal.		$ 200	

SUB-CLASS .002

Dr.		*Cr.*	
(J. E.-2)	$4,000	$4,450	(J. E.-3)
Bal.		$ 450	

SUB-CLASS .003

Dr.		*Cr.*	
(J. E.-2)	$3,600	$2,700	(J. E.-3)
Bal.	$900		

SUB-CLASS .004

Dr.		*Cr.*	
(J. E.-2)	$5,500	$4,350	(J. E.-3)
Bal.	$1,150		

SUB-CLASS .005

Dr.		*Cr.*	
(J. E.-2)	$3,500	$3,900	(J. E.-3)
Bal.		$ 400	

The four groups of accounts to which I have referred in this chapter as pertaining to costs should be ample for the requirements of almost any business. The basic principles of cost accounting hold good for all kinds of industrial activity, and a simple cost-accounting system designed with these as a basis should in most cases be capable of producing the desired results. Certain modifications must naturally be made to fit specific cases, but these modifications should have no effect whatever on the fundamental principles on which all cost systems must depend for success.

No matter what the kind of manufacture, not more than three elements—namely, productive labor, raw material and shop expense—can enter into the cost of the finished product manufactured by the shop. This is an indisputable truism. It is therefore evident, in view of the fact that the amount of labor and

material expended on any product is more or less easily ascertainable, that the whole structure of cost accounting is dependent to a large extent on the proper allocation and distribution of the indirect charges which comprise shop expense.

The Productive Labor, Raw Material, and Shop Expense Accounts as herein outlined, when taken together therefore represent the total cost of this manufactured product. Accordingly all other accounts included in Group D, and in Groups A, E, and L, are used either as a basis for making the proper charges to the Shop Expense Account, or for reflecting the shop output, the cost thereof, or the efficiency of plant operation. A careful study of the simple illustration here used of carrying charges from these three primary accounts through to the Completed Merchandise Account will show how very easily all these requirements can be met without introducing any elaborate or complex cost-finding methods.

Checking Expense Loading Rates.—Another function of the Shop Output Account is that of checking the standard predetermined shop-expense loading rates (burden) with the actual shop expense for the current year. By referring back to Journal Entry No. 2 it will be seen that the Shop Output Account was debited with $22,000, which represented the cost of the finished goods and work in process for the year as taken from a summary of the cost sheets. But the total manufacturing cost for the year as indicated by the charges to the Productive Labor, Raw Material, and Shop Expense Accounts respectively, equaled $24,000. This indicated, then, an error of $2,000 be-

tween the actual cost of manufacturing and the total of the individual cost sheets which had been summarized during the year.

This difference may be due either to clerical errors made in computing these individual costs, or to the fact that the actual shop expense for the current year was $2000 in excess of the standard expense loading rates that had been used during this period. This can of course be very easily checked up by comparing the total expense loading applied to these individual costs throughout the year with the actual shop expense for the same period, as shown by the Shop Expense Account. Any abnormal difference of this kind would therefore require first an investigation to determine whether the increase or decrease in the shop expense for the current year was due to such abnormal causes as strikes, extensive replacements and repairs or similar causes, or whether it was due to conditions that had come to stay, such as increased power consumption due to the installation of automatic machinery, increased rent and shop administrative charges, or other items of a similar nature which would in all probability continue at this same increased outlay. When the latter condition existed, this would necessarily require an entire readjustment of the standard expense loading rates, so that such extra expenses would be proportioned over the output for the ensuing year.

It should not be forgotten that an increase in shop expense for any period as compared with preceding periods does not necessarily mean lax shop administration. Manufacturing executives are often too

prone to look upon an increase in shop expense as a direct loss, when the opposite may be the true state of affairs. This is especially true in such cases as the one above referred to, where increased power expense, depreciation, insurance, taxes, and so on, are incurred because of the installation of automatic machinery which has replaced hand labor, and by virtue of which costs can be materially reduced. Such cases as these, however, can be easily located, and should be considered whenever the question of revising the expense loading rates of the shop is under consideration.

Summary.—From the foregoing outline of the general principles and method of cost-accounting procedure, it becomes evident that the subsidiary ledger plays a very important part in the entire scheme. It should also become more and more evident that through the proper classification of accounts, on which the subsidiary ledger depends for the accuracy of its charges, the degree of profitableness of manufacturing any and all classes of merchandise can be ascertained. In like manner, the subsidiary ledger, when properly arranged, will reflect the workings and the efficiency of any and all departments of the factory. Thus it will enable the management to speed up production whenever necessary and eliminate such kinds of manufacturing work as may be shown to be unprofitable.

There are also certain statistical reports to be discussed later on, which are compiled from data shown on these various subsidiary ledger accounts. These reports are usually designed for the purpose of showing combinations of different factors pertaining to

manufacturing which, when presented in either typographical or graphic form, will further serve as a guide for the management.

Chapters III and IV were intended to show the following points: first, the classification of the plant and its equipment; second, the uniformity of classification that can be arrived at through the numerical system; third, the classification and interpretation of the various controlling cost accounts; four, a segregation of these accounts according to groups; fifth, an analysis of those groups pertaining to manufacturing; sixth, the subsidiary ledger and its functions; seventh, the standardization of journal entries; eighth, the method of measuring the efficiency of the shop management; ninth, the adjusting of standard expense loading rates; and tenth, the importance of considering shop expense in its true significance. The chapters following will deal more specifically with the various cost factors, such as productive labor, raw material and shop expense, considered in this sequence.

CHAPTER V

THE LABOR FACTOR

Classes of Productive Labor.—Labor, when applied in a productive capacity, represents intrinsic value. The worth of this labor depends on the time consumed in performing a specific function, and also on the quality of the workmanship resulting from the expenditure of a given amount of effort in this time.

From a cost-analysis point of view, it is therefore of paramount importance both that the time consumed in producing any article be accurately arrived at, and that the highest quality of workmanship be maintained. A reduction of time that impairs the quality of the product is just as unbeneficial as would be an abnormal increase in time required to produce a masterpiece of workmanship. It therefore stands to reason that only through the exercising of an adequate control over both the time and quality factors, can a happy medium be reached that will be productive of the best grade of workmanship possible in the shortest period of time—or in other words, maximum production at minimum expense.

What we are especially interested in at this stage of our analysis of the various cost factors, is labor directly employed in a productive capacity. This labor may be arbitrarily divided into two main

classes: straight day-work labor and bonus, or piece-work, labor. It is not my intention to discuss in this chapter or in any which follow, the advantages or disadvantages resulting from the use of any of the various wage payment schemes, but simply to consider the method of diagnosing the various forms of labor so that they may be properly assessed against the different kinds of merchandise manufactured. Labor is so intimately connected with cost, and forms such an important element of it, that to many who do not thoroughly appreciate the other component elements, it epitomizes cost itself.

Mass and Unit Production.—As production may be divided into two main classes—mass and unit production, so may productive labor also be divided. In a sugar refinery, for example, where the operatives are engaged day in and day out, month after month and year after year, in performing some specific function as a direct aid to the production of the mass output of the plant, there is not much need for a very accurate distribution of their time while in the factory. All that is required in such cases is that the total time of each workman be included as part of the cost of the output for that time.

However, in a special-tool factory, it is of vital importance that the time of operatives while in the factory be accurately assessed against all orders which may have been worked on during any day, and that this total time be checked against the time which has elapsed from the arrival to the departure of each workman, in order that all the time may be accounted for against specific orders.

In other words, we find in the first example that a simple record only of each workman's "in-and-out" time has to be made, while in the case of unit production—such as found in the special-tool factory—this total must be further analyzed according to what is known as "job" time. The checking of these times with one another, while apparently a very simple process, usually requires extreme carefulness in order that discrepancies may be avoided.

Uses of Time Records.—This brings us then to the point of considering the different purposes of making time records of workmen according to the various jobs to which they have been assigned in the course of a day. In the case of straight day work, where a man is paid so much by the day or hour as the case may be, a division of his time is made simply to get the proportionate charge of his total day wage against each order according to the time which he has actually spent on that order. However, when men are paid on a straight piece-work basis—that is, when they receive so much for each piece which they produce, irrespective of the time employed—these time records are used for quite another purpose.

Shop expense—or overhead, as it is often called—can be properly charged against any job only when the time actually employed in producing it is known.

Without attempting to go into this question of shop expense in too much detail at this time—it will be discussed in a following chapter—suffice to say that piece-work labor cannot be used as a basis for assessing the overhead expense against any job or order, because this expense is not related to piece-work cost.

For example, one workman may be able to assemble by hand fifty per cent more parts in a given period of time than the man next to him, but the shop expense assessable against the entire output of these two men will be exactly the same in both cases. It is evident, then, that in order to ascertain correctly the proper amount of this expense chargeable against any order, it is absolutely necessary to know the time employed in producing it. A great many manufacturers make the mistake of assuming that it is not important to time piece-work operations, but the fallacy of this attitude will be readily apparent from a careful consideration of the simple illustration just used.

Job-Time Records.—While the discussion has dealt only with the importance of keeping records of time on straight day-work and straight piece-work operations, there are also many other forms of wage payment which require this same record. For example, in certain factories a combination day-work and piece-work system is used, while in still others the operatives are paid according to different forms of bonus schemes whereby the workman receives an additional amount of money if he accomplishes his task within a prescribed period of time. It should therefore be apparent that, whatever the form of wage payment, it is of vital importance that the time employed in producing any article be accurately ascertained.

Job-time records have still another function besides that of determining cost. For example, in factories where the piece-work system of payment is in operation, these time records are used not only as a basis

for establishing piece-work prices in the first place, but also to provide a check against these prices after they have once been put into use, in order that they may be fair to both the employer and employee. Then again, they are also used in conjunction with making time and motion studies and in scheduling work throughout the factory. From a management point of view, they are therefore of vital importance from the standpoint of labor control, and in making an analysis of the adaptability of different workmen for special classes of work.

Defects of Straight Day-Work Wage.—The concensus of opinion of those who study the question of wage payment is that the straight day-work wage fails to give satisfactory results even in cases in which one of the other forms of payment would not be applicable. The main reason for this seems to be that it removes any incentive on the part of the individual workman to do more work than he actually must do to hold his job. When a correction of this weakness is attempted in the form of close supervision, the workman soon becomes restive under the impression that he is not trusted, and the result is that the employment department is continually kept busy hiring new workmen to take the place of those who have left to find more satisfactory surroundings.

A study made by the Harvard Graduate School of Business Administration of the wage-payment methods in 165 different factories, showed that 48 per cent of these plants used the day-wage method, 36 per cent straight piece-work, 18 per cent a combination of these two methods, 15 per cent the premium or bonus

method, and the rest a combination of two or more of any of these with—in some cases—contract work included. All told, it was found that in these 165 different factories, 18 different methods of paying workmen were used. In all of these cases, time records would have to be made not only for cost-determination purposes, but also to act as a guide for the management in establishing its policies with respect to the handling of its employes, and the possible substitution of one form or another of wage payment for the one in use under the existing conditions.

Idle-Time Factor.—Another important function of job-time records is that of showing up the loss which occurs where, because of poor scheduling of work, men are required to set up and break down their machines a number of different times a day in order to work on miscellaneous jobs that are being continually assigned to them. While this is often necessary in factories doing a large volume of small contract work, the point that I wish to make clear has to do with those plants, in which, because of mismanagement, a large part of the time of the workmen is each day more or less unproductive.

For example, where ten to fifteen different jobs are assigned to an operative in the course of a day's work, this requires that some sort of record be kept of the time that he actually puts in on each of these jobs, in order that the cost of each may be determined. This leaves, then, one of two alternatives for the recording of this time. Either the workman must leave his bench or machine and report to a time-clerk or time-clock at the start and completion

of each of these jobs, or else he must distribute his own time for the day on some form or other of time-card that may have been provided for that purpose. In the first instance, the workman loses all the time that he is away from his place of work; and in the latter case the factory management makes him perform clerical work, for which he is often unqualified, and then holds him responsible for any mistakes that he may make in so distributing and recording his time.

Time Lost Between Jobs.—As a concrete example of what this time loss amounts to, even when time-clerks are used, let us consider a factory of one hundred employees, having an average wage rate of 25 cents an hour. If there were an average of ten job changes a day for each workman and each man had to report to a time-clerk, whom we shall assume to be centrally located, at the start and completion of each job change, it would not be over-estimating to figure that the time so consumed in reporting to the time-clerk amounted to 3 minutes for each job. This would mean that there was a direct loss of 30 minutes for each workman each day, or an equivalent for the entire shop of 50 hours a day, or 15,000 hours a year. If we extend this time at the average rate of 25 cents an hour, it would mean a direct waste of $3,750.

Keeping in mind the fact that we have only considered a small plant of 100 operatives, we can see that the proportionate time loss in larger plants becomes a factor of considerable expense, any reduction of which is equivalent to just so much interest earned on the outstanding indebtedness of the company. A

careful analysis and study of job-time records would bring this to the attention of the management, and the necessary remedies could then be easily applied. There are a number of different methods and devices on the market today by which this time-waste factor can be eliminated, so far as the actual recording of the time by the workmen is concerned. The further elimination of this waste through proper routing and scheduling of work so that the time lost in needless setting-up of machines may be eliminated, can also be accomplished after it has been brought to attention through the time-records.

In and Out Time.—From this brief analysis of the factor of time-keeping in a manufacturing establishment, it will be seen that the so-called internal problem of time-keeping deserves considerably more attention from a management viewpoint than does the keeping of what is commonly called "in-and-out" time. There is not very much to be said on this general, or "gate," phase of the time-keeping problem, as it simply involves the use of some standard type of equipment, such as recording clocks, on which the men can record their time by inserting a card or punching on a clock-tape their in-and-out records.

These times of arrival and departure from the plant can also be taken by other means, such as having a clerk stationed at the entrance, who notes the time only of those employees who are late or absent. The most common method used, however, is that of the time-clock records, which are made either by the workmen themselves, or by some clerk or watchman to whom this duty is delegated.

Internal Time-Keeping.—But the internal time-keeping presents a problem quite different from the general time-keeping, in that the method adopted varies according to the kind of manufacturing work being done, the area over which the workmen are distributed, the average number of job changes assigned to each workman each day, and the wage-payment plan in operation. In the weaving departments of a textile mill, for example, where the looms are very closely grouped, and where a loom operator may work on a piece of cloth for a certain order possibly three or four days, or even longer, it would hardly be worth the expense to maintain a departmental time-clerk. Under such a condition as this, the foreman could easily take care of these records, since this task would not interfere very much with his executive duties. On the other hand, in the repair shop of a railroad, where the mechanicians work on as many as ten or more different repair jobs in the course of a day, and where it is essential that the cost of repairs be segregated according to the kind of railroad equipment worked on, a job timekeeper would certainly be necessary.

Job Time Records in Rolling Mills.—In a rolling mill, where men are distributed over a large area, and where it is usually impracticable—because of the nature of the work being done—to have the workmen leave the furnaces or machines at which they are performing their respective occupations, the job-time keeping must be attended to either by time clerks, who circulate among the workmen, or by some other means that will not interfere with the order of work

being done. The method of time-keeping is also dependent, to a considerable degree, on the wage-payment plan in use.

For example, in a factory where the men are working on a straight hourly rate, there would be no objection on the part of these workmen to reporting their time to a time-clerk or recording it by means of a time-clock located wherever the management specified. Once put these men on a piece-work basis, however, and they will immediately protest against any order that requires them to leave their benches or machines. In a factory where the piece-work system of payment is used, either entirely or even only partially, this factor has to be considered, and some method of time-keeping must be used which will not raise this objection on the part of the operatives. It is accordingly clear that no definite plan can be laid down for the internal time-keeping of a manufacturing establishment, as this depends on so many local factors that it has to be decided independently in each specific case.

Controlling Piece-Work Operators.—Another important problem that many manufacturers who use the piece-work, or bonus, system of wage-payment have to contend with, is that of piece-workers feeling at liberty to come and go at any time during the day when they may feel inclined to do so. This is quite a serious problem in a number of different industries, and not only complicates the procedure of time-keeping itself, but also interferes in a much larger way with the successful operation of the plant from a management standpoint.

Where such a condition prevails, the planning and routing of work becomes almost impossible, and the cost of the output of the factory is considerably increased because of the fixed charges, such as rent, insurance, taxes, depreciation, and administrative charges, which go on even when no work is being done, and which must under such conditions naturally be assessed against a smaller output than that produced where the workmen are turning out products throughout the entire day. In the large majority of cases in which this condition exists, it could be remedied by stringent action on the part of the management.

On the other hand, however, I know of just such a condition as that here referred to, which exists in a small manufacturing town in Massachusetts. There are some thirty or more comb factories, where, because of keen competition between these different companies, and because of scarcity of help, a factory would immediately lose all of its piece-work operatives if any drastic measures were enforced. In such a case, the situation can be handled in a satisfactory manner only by instituting some sort of bonus system—in addition to the straight-piece work method—whereby the operatives would receive premiums for an output in excess of a certain fixed quantity. It has also been successfully handled by placing departments on a competitive basis and promoting a sense of rivalry between different departments. Whatever the remedy may be, however, the fact remains that it is a factor which must be considered from both a time-keeping and a cost standpoint.

"Mechanism" of Labor Cost Finding.—A careful analytical study of this question of labor cost finding will show that this labor cost can be ascertained solely from the job-time records only in cases in which the labor of the factory is paid for on a straight hour or day rate. In all other cases, this factor of time must be supplemented with the quantity of output and the quality of work done. This introduces, then, the various problems incidental to measuring and inspecting the output, and the various mechanical or other aids that are used in connection therewith, and what might probably be called the mechanism of labor cost finding. The inspection of the output necessitates the use of human, mechanical, electrical, and chemical testing equipment, including devices for measuring liquids and solids and for taking linear measurements—callipers, micrometers, gauges, and other similar instruments. The weighing and counting requires either platform, portable, or self-reading dial and counting scales. The time-keeping factor involves the use of electrical or mechanical time-clocks, stop-watches, electrical, mechanical, dial-printing and figure-printing time-stamps or semi-automatic time-cards.

Where premium payments are made, machine recorders of the dial- or strip-printing kind, tachometers of the mechanical, stationary, portable, electrical or direct-recording kind, machine counters of the revolutionary or operation kind, and speed gauges, are a few of the mechanical aids used to measure the extent of the premiums to be paid to the workmen. In the office, adding and calculating machines and slide

rules, payroll and addressing machines, punch-card, tabulating and sorting machines, and cash and order registers, represent a few more of the mechanical aids that are used in connection with checking and tabulating the labor-cost statistics of the plant.

Payroll Department Routine.—The work of the payroll department of a manufacturing plant consists of assembling this information so that the weekly earnings of each workman may be ascertained. The in-and-out time has to be checked with the time of the men while in the factory. The piece-work and premium wages are kept separate from the staight day-work earnings and records are kept, also, of the deductions or fines for lateness, defective work, and so on, for which the workman is charged. This involves a large amount of detail work in even a small plant; and it will be seen that, because of the fact that employees demand prompt payment when their work has been done, the routine of the payroll department must be conducive not only to accuracy, but also to speed.

Foremen's Clerks.—In a large proportion of manufacturing plants, the time-keeping pertaining to job changes is done by foremen's clerks, who record the time of starting and finishing each job to which each workman is assigned in the course of a day. The accuracy of labor-cost figures depends, therefore, to a large extent on the care exercised by these clerks in making the time records. Furthermore, in order that the payroll department may have the necessary records for making up promptly the weekly earnings of each workman, carefulness must be combined with

speed in assembling the information and turning it in to the payroll department. Every shop clerk must be familiar with the rules of the factory pertaining to the discipline of workmen, and also with all instructions regarding the handling of different kinds of wage-payment schemes which may be in operation.

Maintaining Clerical Efficiency in the Shop.—The organization of the foremen's clerks department is distinct from that of the manufacturing departments. The clerks report to one head clerk on all matters connected with their work, but on the question of discipline they are responsible also to the foreman in charge of the department where they are located. In order to avoid complications, they should never leave the building during working hours without the consent of the head of their department, or before some other clerk has been assigned to carry on the work in their absence. The following is a report made up monthly by a company which grade the clerks according to their efficiency:

A—Excellent.
  Work free from all errors and finished promptly.
  Perfect attendance and punctuality.
  Correct deportment.

B—Good.
  A slight deviation from any one of the requirements mentioned under "Excellent."

C—Fair.
  Deviations consisting of not more than three or four offences against number one mentioned under "Excellent," or a slight deviation from numbers two and three.

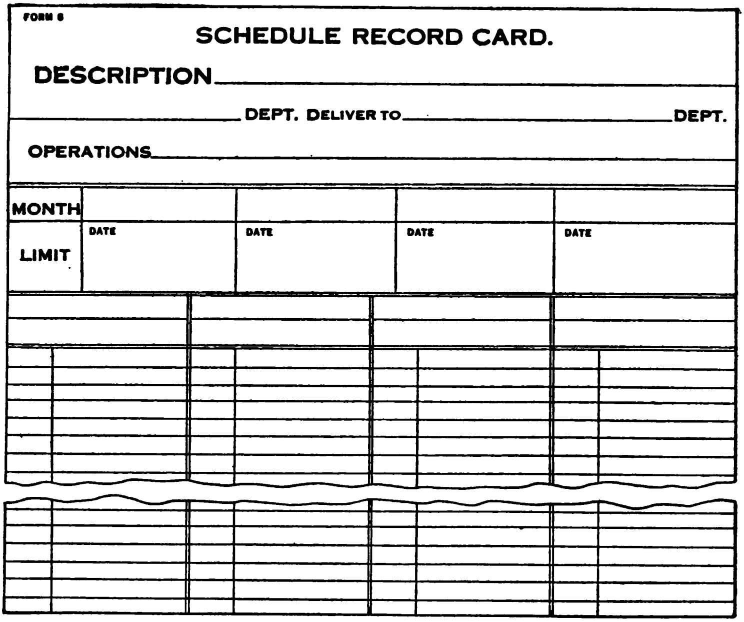
D—Unsatisfactory.
  Low efficiency in any one of the above-named requirements.

A system of grading the clerks in the manner shown above has been found to work out very satisfactorily. Such a system is advisable even in those plants where the other clerical departments are not graded in this way. It is used mainly because so much depends on the accuracy of the records made by these clerks that even slight errors are often the cause of considerable expense and delay in routing and compiling costs of orders passing through the factory. These foremen's clerks are usually located at a desk in a central part of the department to which they are assigned, so that they may be convenient to the greatest possible number of workmen. In some of the large manufacturing establishments, where access to the shop proper can be obtained only by its employees, badges are assigned to these clerks in order that they may visit the office whenever it is necessary to do so.

Duties of Shop Clerical Department.—The work of the foremen's clerks consists in keeping the time on orders, and also in keeping a record of all worked material that is received or delivered by the department to some other part of the shop. All debits and credits of material received or delivered by a department must be posted on order cards (see Form 1, page 37), and the total of such debits or credits on any order be made easily observable. This is best accomplished by bringing totals forward after every three or four entries have been made. These debit or credit entries for materials received or delivered should never be doubled up, but a separate entry should be made for each debit or credit as the case

may be. The debits should be entered by date of receipt of material, and the credits by date of delivery. Where a mistake has been made in the quantity of material forwarded to his department, the clerk should never make this change without the authorization of the head storeskeeper if the material is received from a stock room, or the inspection department if the material has passed through it from a preceding department.

Schedule-Record Card.—A record should be kept of all receipts, all piece-work done on intermediate operations, by operation number, and the deliveries to stores or other departments on a card similar to Form 8. The shop clerk should carefully lay out the card to accommodate all of the records for the period; that is, if it is an order on which deliveries are likely to be made every day, a separate card should be made out for the receipts and one for the deliveries. The heading of each column should be plainly marked, and should show whether the records are receipts or deliveries; the name of the department should also be given. Footings and totals carried forward should be made in red ink in order that they may be easily distinguishable. These schedule-record cards should be carefully watched by the shop clerks in order that the deliveries on any one operation may not exceed the receipts, and that the piece-work quantities on one operation may not exceed those of a previous operation. If any irregularities are noticed, the shop clerk should call the foreman's attention to them, and an adjustment made or an explanation noted at the bottom of the card.



FORM 8. SCHEDULE RECORD CARD

Records of Defectives.—Records of all defective work should be kept separate from those of regular deliveries. If, at the completion of a schedule record card—that is, after all regular deliveries have been made—the records show that there are still defectives on the floor which have not been passed by the inspectors, the destination card or slip accompanying the material should be changed to agree with the actual quantity which is to be forwarded, and the tracing department should be notified of the shortage.

Progress-Record Report.—It quite often happens

that the office requires special information regarding the progress being made on certain orders which are in process of manufacture. When a request for such information is received, Form 9 should be made out in duplicate form the latest available figures shown by the schedule-record card. This report should show whether or not the order is up to schedule time and, if not, whether the material has been received or not. This report is then sent to the office—usually the tracing department—and a duplicate is given to the foreman of that manufacturing department concerning which the report is made.

Old or Doubtful Orders.—Once a month the shop clerk should investigate all old or doubtful orders which are being held up for any reason. This is done by consulting with the shop-order and shop-tracing departments, or the department delivering or receiving the material. In such cases when no definite information regarding these orders can be given by any of these departments, the shop clerk should advise the head of the foreman's clerks department to this effect.

Changing Instructions on Order.—Material should be delivered according to directions on forms and orders, unless the clerk is positive that a mistake has been made in the delivery instructions. In such cases the shop or department should be notified, and authority should be obtained in writing to make the necessary changes. In like manner, it very often happens that a description of an order may be seen to be wrong when received by the shop clerk; the order should not be changed in this case either,

FORM 9

_______________ DEPT. SCHEDULE PROGRESS REPORT. DATE _______________

W. M. NO.	ORDER NO.	SCHEDULE		RECEIPTS		DELIVERIES		REASON FOR NON-COMPLETION
		MONTH	QUANTITY	DATE TO	QUANTITY	DATE TO	QUANTITY	

FORM 9. SCHEDULE PROGRESS REPORT

except upon authorization from those responsible for originating it.

Receiving Material Without An Order.—If material is received before the order on which it is to be charged is received by the shop clerk, the shop-order department should at once be notified and the necessary order should be obtained. No work should be charged by the shop clerk against any orders on which he has not received notification. If it is found that a mistake has been made in noting the order number on the destination ticket accompanying the material, a memorandum should be sent to the clerk in the preceding department asking him to authorize the making of a correction.

The foregoing outline covers in a general way the routine of these foreman's clerks with regard to the handling of records in connection with material received and forwarded by the department in which they are located. My purpose in calling specific attention to these several phases has been to show the ramifications of the work that has to be handled by the shop clerks, and also the responsibility vested in them. It will be readily seen that errors of omission or commission can very easily cause considerable delay and inconvenience, and also ill feeling between departments.

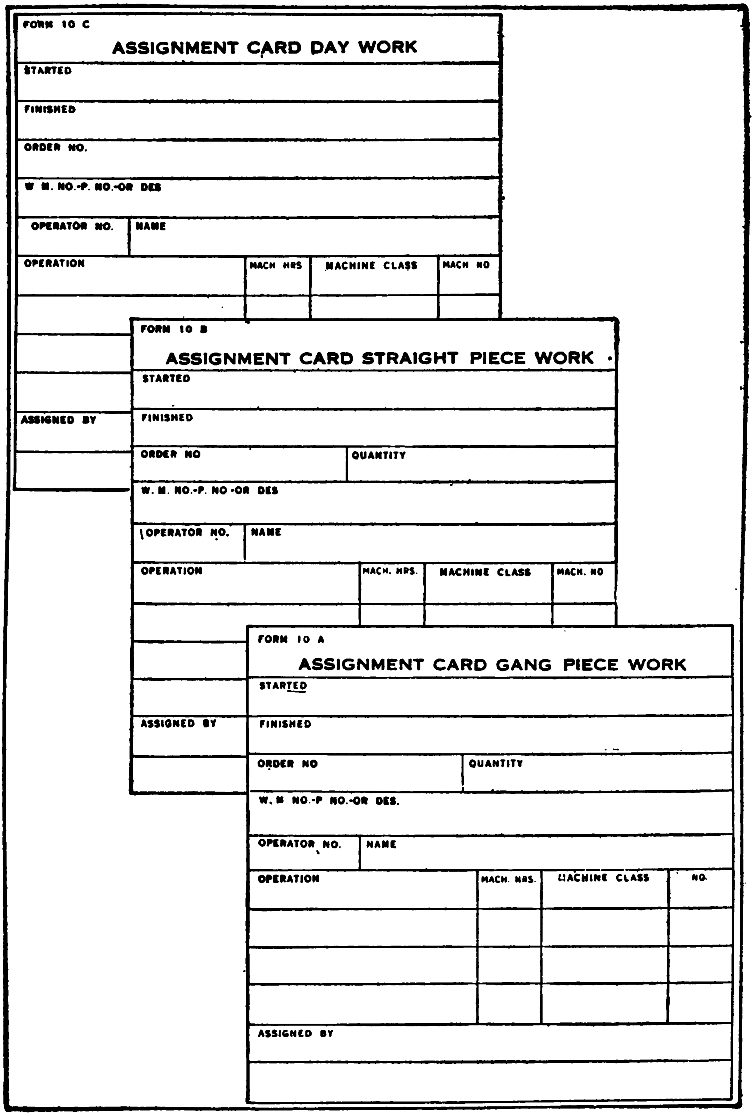
Instructon Book for Clerks.—It is therefore of vital importance that instructions be issued to these clerks in a most specific manner, covering every possible phase of the manufacturing routine with which they may be thrown in contact. This is usually done in well-organized plants by issuing an instruction book

to each clerk, to which he can refer when in doubt. This book should contain a complete set of forms used in the regular sequence of his work, and also such emergency forms as he may have to use at different times. Instructions of this kind are of immense value, since they not only make the work of the shop clerk easier, but help considerably in expediting the movements of materials from one department to another.

CHAPTER VI

TIME-KEEPING AND LABOR COST FINDING

Assignment Cards.—In order that the foreman's clerk may know that a workman has been duly assigned to any job, an assignment ticket made out by the department foreman or one of his assistants, should be given to the timekeeper by the workman assigned to the job. It very often happens that several different kinds of wage-payment methods may be in operation in the same department, and it is therefore essential that the assignment ticket denote the basis of compensation for each job assignment. Form 10 shows specimens of such assignment tickets for (a) gang piece-work, (b) straight piece-work, and (c) day-work. These assignment cards show the date, order number, operator's number, name, and operation to which the workman has been assigned. On receiving the card, the operator stamps the time with a time-stamp on Form 11, which is made up in triplicate form with three detachable stubs. These forms are printed in different colors to denote the different classes of pay. For example, the day-work might be printed in black ink, the straight piece-work in red and the gang piece-work in green. Thus the proper identification is furnished for the payroll and cost departments which later use parts of these tickets.



FORM 10 C

ASSIGNMENT CARD DAY WORK

STARTED

FINISHED

ORDER NO.

W M. NO.-P. NO.-OR DES

OPERATOR NO. | NAME

OPERATION | MACH HRS | MACHINE CLASS | MACH NO

ASSIGNED BY

FORM 10 B

ASSIGNMENT CARD STRAIGHT PIECE WORK

STARTED

FINISHED

ORDER NO | QUANTITY

W. M. NO.-P. NO -OR DES

OPERATOR NO. | NAME

OPERATION | MACH. HRS. | MACHINE CLASS | MACH. NO

ASSIGNED BY

FORM 10 A

ASSIGNMENT CARD GANG PIECE WORK

STARTED

FINISHED

ORDER NO | QUANTITY

W. M NO.-P NO.-OR DES.

OPERATOR NO. | NAME

OPERATION | MACH. HRS. | MACHINE CLASS | NO.

ASSIGNED BY

FORM 10. ASSIGNMENT CARDS

Job-Time Tickets.—When the workman has finished work on an order, and the finishing time has been stamped in the space provided for that purpose on this ticket, the clerk detaches the operator's credit stub (c) and gives it to the workman as a receipt for the work done by him. The main part of this ticket, (C) is retained by the clerk as his record. Ticket A, together with the tracing record stub (a), attached thereto, is sent to the payroll department, which keeps the ticket (A), detaching stub (a), which it sends to the tracing department. This provides the payroll department with the necessary information regarding the earnings of the workman, and also keeps the tracing department posted as to the progress being made on any order.

Destination Tickets and Delivery Records.—Having disposed of the first and last copies in this manner, the clerk takes the middle section and places it on the tray which contains the materials to which this order refers. The main part of this slip (B) is an identification ticket and the stub (b) is what is called a department-debit ticket. These remain attached to each other until they reach the next department, where the stub is then detached by the porter and given to the clerk in that department. The identification ticket (B) remains with the material. On receipt of this debit ticket (b) the clerk makes the necessary entry on his order form, Form 8 (see preceding chapter), showing that the material is a charge against his department and then notifies the foreman that the material is available to be worked on.

While it is rather perplexing to follow the form

OPERATORS CREDIT	DEPARTMENT CREDIT AND TIME RECORD						
TO	TO		STARTED				
ORDER NO	ORDER NO.		FINISHED				
OPERATOR	OPERATOR NO.	NAME					
P. NO.-W. M. NO.-DESC.	P. NO.-W. M. NO.-DESC.						
QUANTITY GOOD	QUANTITY GOOD	CARD NO.	INSPECTED BY				
DEFECTIVES PAID FOR	DEFECTIVES PAID FOR	OPERATION NO.	COUNTED BY				
OPERATION NO.	TOTAL CREDIT	PRICE					
	TOTAL DEFECTIVES		TOTAL HOURS				
	WEEK ENDING	SUN.	MON	TUES.	WED	THURS	FRI	SAT
DATE OF DELIVERY	DATE OF DELIVERY	TOTAL CREDIT TO DATE	ENTERED ON ORDER BY				
FROM	DEPARTMENT	MACH. HRS.	MACHINE CLASS	NO.			

DEPARTMENT DEBIT	DESTINATION CARD						
TO	TO		STARTED				
ORDER NO.	ORDER NO.		FINISHED				
OPERATOR	OPERATOR NO.	NAME					
P. NO.-W. M. NO.-DESC.	P. NO.-W. M. NO.-DESC.						
QUANTITY GOOD	QUANTITY GOOD	CARD NO.	INSPECTED BY				
	DEFECTIVES PAID FOR	OPERATION NO.	COUNTED BY				
OPERATION NO.	TOTAL CREDIT	PRICE					
	TOTAL DEFECTIVES		TOTAL HOURS				
ENTERED ON ORDER BY	WEEK ENDING	SUN.	MON.	TUES.	WED.	THURS.	FRI	SAT.
DATE OF DELIVERY	DATE OF DELIVERY	TOTAL CREDIT TO DATE					
FROM	DEPARTMENT	MACH. HRS.	MACHINE CLASS	NO.			

FORM 11 TRACING RECORD	STRAIGHT P. W. CREDIT & TIME TICKET						
TO	TO		STARTED				
ORDER NO.	ORDER NO.		FINISHED				
OPERATOR	OPERATOR NO.	NAME					
P. NO.-W. M. NO.-DESC.	P. NO.-W. M. NO.-DESC.						
QUANTITY GOOD	QUANTITY GOOD	CARD NO.	INSPECTED BY				
	DEFECTIVES PAID FOR	OPERATION NO.	COUNTED BY				
OPERATION NO.	TOTAL CREDIT	PRICE	LABOR				
	TOTAL DEFECTIVES		TOTAL HOURS				
ENTERED BY	WEEK ENDING	SUN	MON.	TUES.	WED.	THURS.	FRI.	SAT.
DATE OF DELIVERY	DATE OF DELIVERY	TOTAL CREDIT TO DATE	LAB. LOAD				
FROM	DEPARTMENT	MACH. HRS.	MACHINE CLASS	NO.			
	CERTIFIED BY						

c B b A a

FORM 11. TIME CARD USED FOR STRAIGHT PIECE WORK OPERATIVE

In practice the three forms are printed on one card, Form B, b, being on the reverse side, so that when folded the items on Forms B, b, and C, c, will be directly behind the corresponding items on Form A, a.

in an explanation of this kind, an examination of the front and reverse sides of the triplicate form, as given on the opposite page will show very plainly the simplicity of arrangement. This is without doubt one of the best forms that have ever been designed as a combination time-ticket, destination-ticket, payroll-department record, tracing record, operator's memorandum, and department notification slip. I call especial attention to it because of its simplicity and the many functions that it performs.

Notice of Transfer.—When an employee is transferred from one job to another before he has completed the work that he is engaged on, a new assignment card should be made out by the foreman, and the clerk should be notified in exactly the same way as if the job had been completed. It is not necessary for the clerk to keep these assignment tickets for more than a few weeks, after which time they can be destroyed. All filing of time tickets and other records should be done behind guide cards to facilitate locating them. They should be arranged by dates in order that the time-tickets for any day may be easily withdrawn and summarized.

Completion of Orders.—The shop clerk should keep a careful watch over the schedule-record cards (Form 8, page 103) to see that prompt notification is sent to the cost department as soon as an order has been completed. This is done by making out a slip similar to Form 12, which is simply a notification to that effect.

Time-Keeping and Delivery of Material.—It is the duty of the time clerk to see that time is properly

FORM 12 ______________ 191

______________ DEPT.

WE SENT YOU THE LAST LOT OF ______________.

W.M. ______________ ON ORDER ______________ S

ON ______________ 191

______________ DEPT.

RECEIPTS ______________ DELIVERED ______________

RECEIPTS ______________ DELIVERED ______________

FORM 12. COMPLETION OF ORDER

charged to jobs each day, and that no estimate of time is made in any case. Order numbers should be taken from the order cards, or where the work is done on expense orders—that is, work done for the shop itself—the expense order number should be clearly shown. A card file which contains guide cards bearing the clock number of each operator, filed numerically should be used for holding time tickets. When an operator is started on a job, the time started, description, and operator's name and number should be properly and plainly filled in and filed behind the operator's guide card. It remains there until either the operator is changed to another job,—the end of the week—or until it is necessary to make a delivery of material, when it is removed and the "time finished" is entered in the proper space. The elapsed time between the start and the finish should be entered for the different days, and the "machine hours," "class" and "number" should also be entered.

Before allowing the ticket to leave his hands, the shop clerk should carefully check it to see that there are no omissions, and that it is stamped with the total hours for that week and bears the department stamp.

Removing Piece-Worker Temporarily.—After a piece-work operator has begun working on a job, and it is found necessary to change the job before the material is ready for delivery, the time ticket should be closed; that is, the time finished should be entered in the proper space, but no time should be marked in the spaces for the different days. It should be retained in the time file by the clerk until the operator again resumes work on the same job, when the time started should again be entered, and the ticket should be handled in the regular way until the job is completed, when the total elapsed time should be filled in the spaces for the different days (see Form 11). Exceptions should be made only if this case happens at the end of a week, when the ticket should be marked "Credit" in the space for quantity, and the succeeding time ticket should be stamped "Time on Preceding Ticket."

Time on Preceding Ticket.—All material delivered on forms having time-ticket combined with destination cards—such as Form 11—should have the time charged for each delivery made. If for any reasons the time charged does not cover the total time spent on the lot delivered, the ticket should be stamped "Time on Preceding Ticket," and the reason for dividing the time should be stated on the back of the time-ticket.

Machine-Class Hours and Number.—The reader will recall that in a preceding chapter mention was made of the fact that a shop cost is made up of three elements, namely, productive labor, raw material, and manufacturing expense. It is to this last element, manufacturing expense, that attention must be called at this time. In those manufacturing plants where the analysis and distribution of this expense has been carried out to a fine point, it is assessed against individual jobs by what is known as the machine-unit system. This consists of so allocating the manufacturing expense that each machine will bear its just portion in the form of a rate per hour. This is called the "machine loading rate." Metal tags, which are permanently fastened to the machines indicate its number and also its rate, in the form of a code. This code is used so that the workmen will not know the expense loading rate of machines in the factory. For example, the letters M. L. C. D. might mean a certain type of milling machine with a rate of ten cents an hour; the same system is used to denote other types and rates by other combinations of letters, such as those that have just been referred to. It is not my intention to go into this question of the machine-hour rate of expense distribution at this time, but simply to call attention to it from the viewpoint of the records which are required, and which in turn must be made by the shop clerks on the time-tickets.

The machine-class hours and number should be carefully entered in the proper space on all time-tickets, with the exception of those covering overtime allowed for piece-work and the time of "ex-

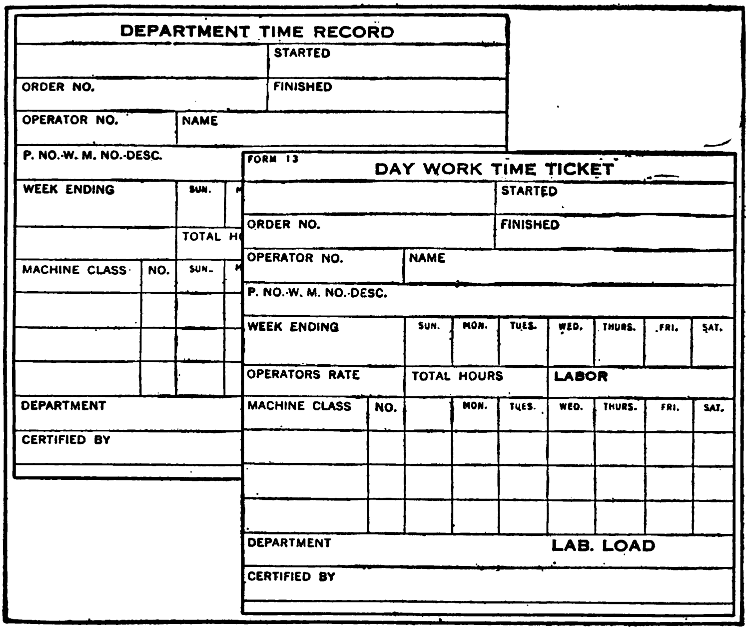
pense employees," such as assistant foremen, shop clerks, porters, monitors, and so on.

Machine-class letters are obtained from the metal tags that are attached to the machines. The machine hours are the actual hours an operator works. A division of time should be made if the operator works on more than one machine class, and the proper time should be charged to each class. When an operator works on more than one machine at the same time—as he often does in the case of automatic screw machines—the number of machines of each class so operated should be entered on the time-ticket.

Overtime Piece-Work.—Whenever it is necessary to have piece-work operators work overtime, they are naturally entitled to additional recompense for the extra time, provided that is the general policy throughout the shop. In such cases, a day-work time-ticket form similar to that of Form 13 should be made out by the time-clerk, covering the extra time allowed by the company. No machine hours or machine class should be entered on this ticket, but the word "overtime" should be stamped in the place of the machine class.

Overtime Day-Work.—This same time-ticket is used for showing overtime of straight day-work operatives, but instead of showing the hours in the spaces for the different days, only those hours including the extra time that the operator is to be paid for should be indicated. The machine hours are entered in the same manner as explained in the preceding paragraph for piece-work overtime operatives.

Delivery of Time-Tickets.—The delivery of day-



DEPARTMENT TIME RECORD

	STARTED
ORDER NO.	FINISHED
OPERATOR NO.	NAME
P. NO.-W. M. NO.-DESC.	
WEEK ENDING	SUN.
	TOTAL H
MACHINE CLASS · NO.	SUN.
DEPARTMENT	
CERTIFIED BY	

FORM 13

DAY WORK TIME TICKET

			STARTED					
ORDER NO.			FINISHED					
OPERATOR NO.		NAME						
P. NO.-W. M. NO.-DESC.								
WEEK ENDING		SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
OPERATORS RATE		TOTAL HOURS		LABOR				
MACHINE CLASS	NO.		MON.	TUES.	WED.	THURS.	FRI.	SAT.
DEPARTMENT				LAB. LOAD				
CERTIFIED BY								

FORM 13. DAY WORK TIME TICKET

In practice the two forms are on one card, the lower form being on the reverse in such manner that when the card is folded the items will be directly behind corresponding items on the upper form.

work and piece-work time-tickets by the shop clerical force to the payroll department is, of course, subject to the specific governing factors and the method of paying off in each individual factory. The main point of importance, however, is that whatever the method may be, or whatever the time scheduled for is, all time records should be turned in on time. In order to keep this matter of promptness constantly before the shop clerical department, the payroll departments should send a weekly report to the shop superintend-

ent and a copy thereof to the head of the shop clerical department, of all deliveries made after scheduled time.

Missing Time-Tickets.—In making up the weekly payroll and in checking the total time turned in on time-tickets by the shop clerical department with the total time each workman has been in the factory as taken from his in-and-out clock records, discrepancies quite often appear; that is, the two times often do not agree. In such a case, a memorandum should be sent by the payroll department at the latest possible moment before closing the payroll, showing all such time missing or unaccounted for. These memoranda should be sent to the shop clerks by special messengers, and should be given immediate attention by those clerks. The shop clerks, on receipt of such memoranda, should locate the "department time-record" or "department credit," from which an adjustment in the payroll may be made. Upon request from the payroll department, a duplicate time-ticket should be issued, plainly stamped "duplicate" at the top of the ticket.

Piece-Work Operations.—In no case should an operation be done on a day-work basis when a piece-work rate is available. If for any reason it is necessary to do such a operation on a day-work basis, a regular piece-work time-ticket should be made out and plainly stamped "to be paid day-work," and signed by the foreman. The reason for the change should be noted on the back of the time-ticket and the department-credit coupon. This piece-work time-ticket refers to Form 11.

Work for Department Use.—When work is done on a job, and on completion is not forwarded to another department, Form 14 is used for piece-work operations, and Form 13 for day-work operations. When the work has been inspected in the department and small lots have been delivered at a time, the inspector holds the slip headed "Operator's Credit" of this triplicate form, and enters the credit on the back of it for each lot received, accompanied by an indentification card, Form 15. After all the work has been completed, the remaining duplicate slips of Form 14 are then turned over to the inspector, who enters the total quantity on all duplicate slips of this triplicate form by inserting carbon sheets. He then returns the slips headed "operator's credit" and "department credit and time-record" to the departmental clerk, and forwards the time-ticket to the payroll department. After the department clerk receives the two slips above referred to, he detaches one from the other and gives the operator his credit slip and retains the department-credit slip for his own record.

Delivery of Material.—It is essential that all material leaving a department be accompanied by either a destination card or an inspection ticket, and be delivered through the inspection department and the counting room. Destination tickets should give full information with reference to parts being sent to other departments, in order that they may be properly inspected. When it is not possible to give a complete description of this kind on the destination tickets, the blue-print or specification number should be given; if this is not obtainable, a brief description

OPERATORS CREDIT

TO		STARTED
ORDER NO.		FINISHED
OPERATOR NO.	NAME	
P. NO. W. M.-DESC.		
QUANTITY GOOD	CARD NO.	INSPECTED BY
DEFECTIVES PAID FOR	OPERATION NO.	COUNTED NO.
TOTAL CREDIT	PRICE	
TOTAL DEFECTIVES		TOTAL HOURS
WEEK ENDING	SUN. MON. TUES. WED. THURS. FRI. SAT.	
DATE OF DELIVE		
DEPARTMENT		
CERTIFIED BY		

DEPARTMENT CREDIT & TIME RECORD

TO		STARTED
ORDER NO.		FINISHED
OPERATOR NO.	NAME	
P. NO.-W. M.-DESC.		
QUANTITY GOOD	CARD NO.	INSPECTED BY
DEFECTIVES PAID FOR	OPERATION NO.	COUNTED NO.
TOTAL CREDIT	PRICE	
TOTAL DEFECTIVES		TOTAL HOURS
WEEK ENDING	SUN. MON. TUES. WED. THURS. FRI. SAT.	
DATE OF DELIV		
DEPARTMENT		
CERTIFIED BY		

FORM 14

STRAIGHT P.W. CREDIT & TIME TICKET

TO				STARTED					
ORDER NO.				FINISHED					
OPERATOR NO.	NAME								
P. NO.-W. M.-DESC.									
QUANTITY GOOD	CARD NO.				INSPECTED BY				
DEFECTIVES PAID FOR	OPERATION NO.				COUNTED NO.				
TOTAL CREDIT	PRICE				LABOR				
TOTAL DEFECTIVES					TOTAL HOURS				
WEEK ENDING	SUN	MON	TUES.	WED	THURS	FRI	SAT		
DATE OF DELIVERY	TOTAL CREDIT TO DATE				LAB. LOAD.				
DEPARTMENT				MACH. HRS.	MACHINE CLASS	NO.			
CERTIFIED BY									

FORM 14. PIECE WORK CREDIT TICKET

FORM 15 IDENTIFICATION CARD	
TO	
ORDER NO.	JOB NO.-P. NO.
OPERATOR NO.	NAME
OPERATION	
QUANTITY	
DEPARTMENT	DATE
THIS CARD MUST REMAIN WITH MATERIAL	

FORM 15. IDENTIFICATION CARD

supplemented with the notation "See Order," or some similar quotation, should be made, in order that the inspector may refer to it for a fuller description.

A separate destination ticket should be made out for each different kind of part. If the destination is the same after different operations, the destination ticket should be plainly marked either "First operation" or "Second operation," as the case may be.

Material Sent to Wrong Destination.—When it is found that material has been received through error by some department not entitled to it, the clerk in that department should immediately notify the clerk of the department that sent the material, and should learn the correct destination, which he should note on the destination card. Then he should have the de-

partment porter deliver the material to the proper department. The clerk in the department that originally sent the material should then change his record and notify the shop tracing department.

Junk Destination Tickets.—Whenever the inspection department finds material unfit for use, Form 16 is made out. A coupon of this form will be sent to the department delivering the material, a record of which sholud be entered on order cards separately from all other records.

Material to Be Repaired.—When material received by the inspection department is found to have been damaged by improper handling, or when the work itself is defective, or when possibly some operations have been omitted, a form similar to Form 17 should be made out. The inspector specifies on this form the departments through which the work should pass to have this repair work done, and also the nature of the defects. The entire lot of this material should be kept intact, whenever it is possible to do so, and handled as a lot. If it is necessary for some specific reason—on account of rush orders, for example—to separate the defective work from the good work while the material is in the department, a form similar to Form 17 should be filled out exactly the same as the identification coupon of Form 18, and placed in each pan or tray of material holding the different lots. When delivered material is received with this card, the clerk should fill out Form 18, and send the material to the next department specified. The record of defectives should be kept separate from the regular deliveries.

FORM 16

TRACING RECORD	DEPARTMENT CREDIT--DEFECTIVES JUNKED	
ORDER NO.	ORDER NO.	
JOB NO.	JOB NO.	
QUANTITY	QUANTITY	
DEFECTS	DEFECTS	
DATE	DATE	ENTERED ON ORDER BY
FROM	FROM	INSPECTOR
ENTERED MATERIAL DEPT. / ENTERED TRACING DEPT.	RECORDS OF DEFECTIVES JUNKED MUST BE KEPT SEPARATE FROM RECORDS OF DEFECTIVES REPAIRED AND REGULAR DELIVERIES.	
DEFECTIVES JUNKED		

JUNK	DEFECTIVES JUNKED
ORDER NO.	ORDER NO.
JOB NO.	JOB NO.
QUANTITY	QUANTITY
DEFECTS	DEFECTS
DATE	DATE
FROM	FROM
	THIS PART TO BE SENT TO THE COST DEPARTMENT
THIS PART TO ACCOMPANY MATERIAL TO JUNK DEPT.	

FORM 16. JUNK DESTINATION TICKET

ORIGINAL

FORM 17

TRACING RECORD

FOR

ORDER NO.

W. M. NO.

COUNTED BY

QUANTITY GOOD

ENTERED ON TRACING SHEET BY

DATE

FROM

DEFECTIVES REPAIRED

INSPECTION RECORD

FOR

ORDER NO. | MATERIAL INSPECTED IN DETAIL—GENERAL

W. M. NO.

COUNTED BY | INSPECTED BY

QUANTITY GOOD | TOTAL DEFECTIVES | ENTERED BY

DEFECTS

FROM | DATE

RETURN THIS TICKET TO INSPECTOR

DUPLICATE

DEPARTMENT DEBIT

FOR

ORDER NO.

W. M. NO.

COUNTED BY

QUANTITY GOOD

ENTERED ON ORDER BY

DATE

FROM

RECORDS OF DEFECTIVES MUST BE KEPT SEPARATE FROM REGULAR DELIVERIES.

DEFECTIVES TO BE REPAIRED

THIS CARD MUST REMAIN WITH MATERIAL

FOR

ORDER NO.

W. M. NO

COUNTED BY | INSPECTED BY

QUANTITY GOOD | TOTAL DEFECTIVES

DEFECTS

FROM | DATE

THIS MATERIAL SHOULD BE HANDLED AS ONE LOT

TRIPLICATE

FOR

ORDER NO

W. M. NO.

DATE

FROM

DEPARTMENT CREDIT—DEFECTIVES REPAIRED

FOR

ORDER NO

W. M. NO

COUNTED BY

QUANTITY GOOD | TOTAL DEFECTIVES | ENTERED ON ORDER BY

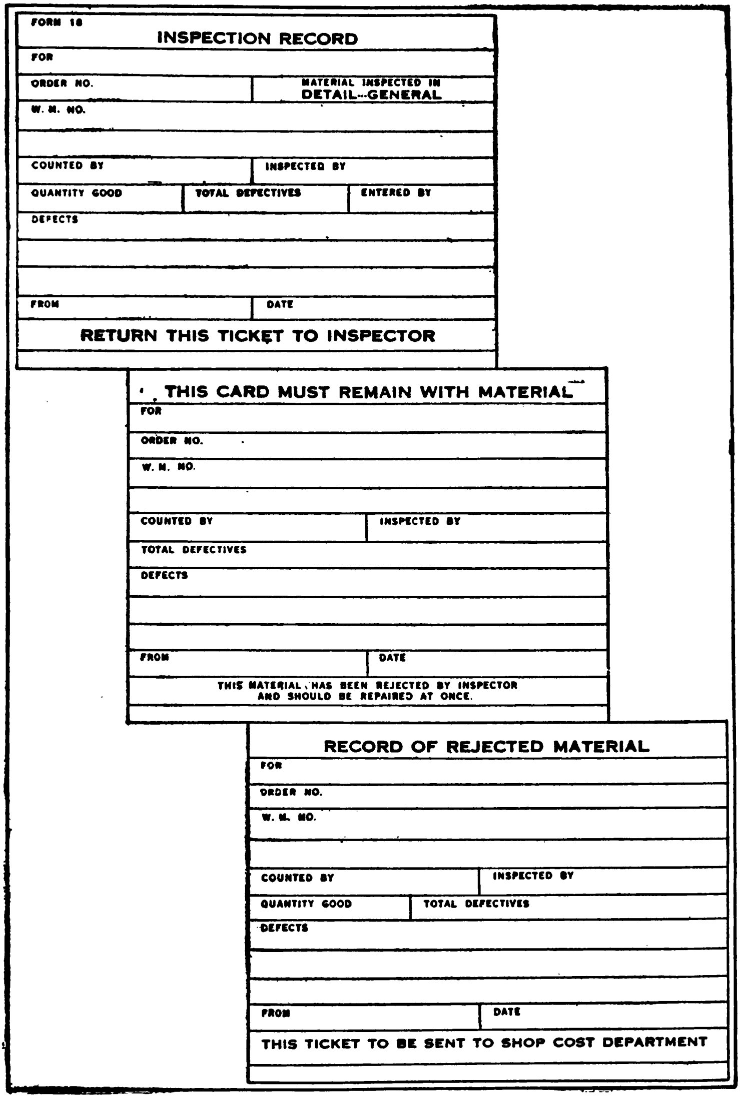
DEFECTS

FROM | DATE

RECORDS OF DEFECTIVES MUST BE KEPT SEPARATE FROM REGULAR DELIVERIES

FORM 17. INSPECTION RECORD FOR DAMAGED MATERIAL TO BE REPAIRED

This form is made up and used in a manner similar to Form 11.



FORM 18

INSPECTION RECORD

FOR

ORDER NO. | MATERIAL INSPECTED IN DETAIL—GENERAL

W. M. NO.

COUNTED BY | INSPECTED BY

QUANTITY GOOD | TOTAL DEFECTIVES | ENTERED BY

DEFECTS

FROM | DATE

RETURN THIS TICKET TO INSPECTOR

THIS CARD MUST REMAIN WITH MATERIAL

FOR

ORDER NO.

W. M. NO.

COUNTED BY | INSPECTED BY

TOTAL DEFECTIVES

DEFECTS

FROM | DATE

THIS MATERIAL HAS BEEN REJECTED BY INSPECTOR AND SHOULD BE REPAIRED AT ONCE.

RECORD OF REJECTED MATERIAL

FOR

ORDER NO.

W. M. NO.

COUNTED BY | INSPECTED BY

QUANTITY GOOD | TOTAL DEFECTIVES

DEFECTS

FROM | DATE

THIS TICKET TO BE SENT TO SHOP COST DEPARTMENT

FORM 18. INSPECTION RECORD

FORM 19 INSPECTION RECORD		
FOR		
ORDER NO.	MATERIAL INSPECTED IN DETAIL—GENERAL	
COUNTED BY	INSPECTED BY	
QUANTITY GOOD	TOTAL DEFECTIVES	ENTERED BY
FROM	DATE	
RETURN THIS TICKET TO INSPECTOR		

FORM 19. INSPECTION RECORD

Reports on Defective Material.—The inspection department should make out each day a report of all defective material that has been passed on by them. This report should be made out in duplicate; it should show an itemized list of all material inspected in detail, and the various defects of each lot. The duplicate copy should be sent to the foreman and filed in a binder provided for that purpose, the original being retained by the inspection department. A daily summary should be made, showing the material inspected for each department, on which is shown the

percentage of defective work, as follows. (See Forms 17, 18, and 19):

Total quantity of material handled and per cent defective.
Quantity given detailed inspection, and per cent defective.
Total quantity defective, quantity repaired, and quantity junked.

A weekly report should be made out, showing the total defectives chargeable against each department, and a copy of the report should be sent to the shop superintendent, who will take the necessary steps to curtail excessive defective work in any one department.

Repairs to Small Tools.—Whenever it is necessary to have tools repaired, a form similar to Form 20 should be used. This requisition for repairs is made up in three parts, and should be so folded that the original will bear the foot-note reading, "This part to accompany tool to department making repairs, where it will be filed as their record." When filled out, the triplicate should be detached and kept as a record until the repaired tool has been returned accompanied by the duplicate. This duplicate should be printed in ink of a different color in order that it may be easily distinguishable from the other parts. The tool to be repaired should be sent with the original and duplicate parts to the department making repairs, where they will be separated. The duplicate sholud be placed in a temporary file, and the original should remain with the tool until the repairs have been completed.

The operator should state on the original the time required to do the job, and in the space marked

REQUISITION FOR REPAIRS TO SMALL TOOLS

TOOL No.________________ DATE________________191___

________________DEPT. IS MAKING THE FOLLOWING REPAIRS

CHARGE TO____________TOOL FOR______________DEPT.

ORDERED BY______________

THIS PART TO BE FILED BY DEPARTMENT MAKING REQUISITION

REQUISITION FOR REPAIRS TO SMALL TOOLS

TOOL No.________________ DATE________________191___

________________DEPT. DO WORK SPECIFIED BELOW

CHARGE TO____________TOOL FOR______________DEPT.

ACCEPTED BY__________191_____ORDERED BY______________

REJECTED BY__________191_____WORK FINISHED__________191___

THIS PART TO ACCOMPANY TOOL TO DEPARTMENT MAKING REPAIRS WHO WILL RETURN SAME WITH TOOL WHEN REPAIRED

FORM 20

REQUISITION FOR REPAIRS TO SMALL TOOLS

TOOL No.________________ DATE________________191___

________________DEPT. DO WORK SPECIFIED BELOW

CHARGE TO____________TOOL FOR______________DEPT.

OPERATOR__________HRS._______ORDERED BY______________

OPERATOR__________HRS._______WORK FINISHED__________191___

THIS PART TO ACCOMPANY TOOL TO DEPARTMENT MAKING REPAIRS WHERE IT WILL BE FILED AS THEIR RECORD

FORM 20. REQUISITION FOR REPAIRS TO SMALL TOOLS
The middle card is reversed and printed up-side-down, as described for Form 11.

"Work finished" he should note the last date worked. The tool should then be sent to the inspection department, accompanied by the duplicate part. The tool-inspector will fill in "Date accepted," and forward to the department specified. If the repaired

FORM 21

TOOL REQUISITION

DATE ________________ 191 __

TOOL DRAUGHTING DEPARTMENT:

PLEASE ORDER FOR ________________ DEPT.

THE FOLLOWING ________________

SIGNED ________________

ORDER & DETAIL NO. ________________

B. P. NO. ________ TOOL SKETCH NO. ________

TO REPLACE ________________

CHARGE TO ________________

NEW TOOL NOS. ________________

ISSUE ORDERS ON	TO MAKE

ORDERS ISSUED ________ 191 ________

FORM 21. TOOL REQUISITION

tool is rejected, it should be returned to the department making repairs, accompanied by the duplicate part, which will be placed on file, and the same routine as specified above will be followed.

Tool Requisition.—When a department foreman wants a new tool, he makes out a tool requisition similar to Form 21. This requisition should show the part number and the piece for which the tool is designed; or if the tool is to be used on a general order, the order number should be given. A notation should also be made on this form of the number of the tools that are to be replaced—if any—by the new tool.

Attendance Records.—In order to assist the payroll department in checking its records of the in-and-out time of employees who are on an hourly rate, the departmental clerk should keep a record of the attendance of all employees in his department. A record of this kind can be kept on a form similar to Form 28, page 138, which, it will be seen, is arranged to take care of a period of six months. In order that these records may be kept in as concrete a form as possible, the usual practice is to have the notations made by means of symbols. This can be done in the following manner:

Full time or overtime--9
(Hours worked, in blue ink)
Shop shut down all day or men laid off-------------------------X
("X" in blue ink)
Holidays --H
("H" in blue ink)
Absent without being excused-----------------------------------A
("A" in red ink)
Excused all day--E
("E" in red ink)

Excused part of day ---------- E-5
(Hours worked, with "E," in red ink)
Sick all day ---------- S
("S" in red ink)
Sick part of day ---------- S-4
Hours worked, with "S," in red ink)
Late ---------- 6
(Hours worked, in red ink)
Late (card taken by watchman) ---------- C-8
(Hours worked, with "C," in red ink)
Absent all day on injury ---------- I
("I" in red ink)
Absent part of day on injury ---------- I-5
(Hours worked, with "I," in red ink)

The operator's weekly rate should be entered at the upper left-hand corner above "Clock number," as illustrated. The column headed "Wages" should be filled in each week from the pay receipts. Extensions of "Times late" should be done with red ink. If there is no lateness, the space should be left blank. If an operator is transferred to another department, his attendance record should be forwarded to his new foreman, who will give it to the clerk in his department.

Overtime Requisitions.—When the foreman considers it necessary to have his department, or any part of it, work overtime, a form similar to Form 22 should be sent to the shop-order department at least one hour before the close of the regular day. On this form should be noted what service will be needed—such as light, power, compressed air or elevator service. On receipt of this overtime requisition, the shop order department—if it approves—will notify the service departments, in order that the service for that department may be kept in operation after the close of the regular day.

FORM 22

OVERTIME REQUISITION

Date,________________191

SHOP ORDER DEPT:-

MEN	UNTIL	LOCATION	LIGHT	POWER	COMPRESSED AIR	ELEVATOR	WORK

____________________Dept.

FORM 22. OVERTIME REQUISITION

Overtime Passes.—Each operator who is required to work overtime should have an overtime pass properly signed either by the foreman or by one of his duly authorized assistants. This pass can then be used by the workman to gain admittance to the building after his supper period. A watchman will take up these passes and forward them to the payroll department, where they will serve as notification of overtime to be looked into.

Employee Passes.—If it is necessary for workmen to leave the shop during working hours, a pass similar to Form 23 should be made out, stating whether the employee is leaving on company or personal business, and whether or not he is to return. This pass should be signed by the foreman person-

FORM 23

________________ 191__

WATCHMAN:

Pass ____________________ No. ________

going out on ____________ business, to ____________

____

Out at ________ M. ________ In at ________ M.

____
FOREMAN

____
WATCHMAN

FORM 23. EMPLOYEE PASS

ally, or by one of his authorized assistants, and taken up by the watchman and forwarded in the same manner as the overtime passes.

Package Passes.—Form 24 should be made out for all employees who have packages to take out of the

COUNTERSIGNED

FORM 24

SMITH-JONES COMPANY.

NEW YORK.

WATCHMAN: DATE ____________

________________ NO. ________

HAS PERMISSION TO PASS OUT OF THE BUILDING WITH ________ PACKAGES WHICH CONTAIN PERSONAL PROPERTY AS FOLLOWS ________________

____

____
FOREMAN

This pass must be countersigned by the GENERAL FOREMAN or SHOP SUPERINTENDENT, and collected by the WATCHMAN

FORM 24. PACKAGE PASS

factory. It should state the contents of the package, and should be signed by the foreman personally and countersigned by the general foreman or shop superintendent. This is a precaution against theft and indiscriminate shipping of goods without proper authority.

Paying Off Employees.—Pay receipts for all employees at work on their pay-day should be signed by employees before the paymaster reaches the de-

FORM 25

DATE, ________________ 191__

PAY ROLL DEPARTMENT

PAY BEARER ______________________ NO. __________

STILL IN OUR EMPLOY BUT ABSENT ON PAY DAY OF ________________ 191__

SIGNATURE ______________________

WITNESSED ______________________
FOREMAN

FORM 25. ABSENT ON PAY DAY

partment. Those receipts for employees absent on their pay-day should be promptly returned to the payroll department. If employees are paid from the paymaster's window, as they are in some cases, the pay receipts should be signed in like manner before the men reach the paymaster, in order that no delay may be incurred at the window.

Employees Absent on Pay-Day.—When an employee is absent on pay-day, he should have the fore-

man or one of his assistants identify him by signing Form 25, which he presents to the pay-master. The signature of the person vouching for him should then be compared by the paymaster with his signature on file and also with the signature of the employee.

Employees Discharged or Leaving.—When an employee is discharged or leaves the employ of the com-

FORM 26

PAY ROLL DEPT.

DATE________________191___

PLEASE PAY BEARER

____________________NO.__________

LEAVING OUR EMPLOY { OF OWN ACCORD / DISCHARGED

LAST DAY WORKED________________191___

SIGNATURE____________________

WITNESSED________________
FOREMAN

TOOLS RETURNED____________________

FORM 26

EMPLOYMENT DEPT.

LAST DAY WORKED________________191___

____________________NO.__________

IS LEAVING OUR EMPLOY FOR FOLLOWING REASON:

CHARACTER OF WORK		
GOOD	FAIR	N.G.

FOREMAN

FORM 26. NOTICE OF DISCHARGE

pany, a form similar to Form 26 should be filled out in ink and signed on both parts by the foreman or his authorized assistant after the employee's signature has been witnessed. On the part headed "Payroll department" either the notation "Of own accord" or "Discharged" should be scratched out. This part should then be given to the employee who is leaving, who is sent to the payroll department accompanied by someone who will identify him. The part headed "Employment department" should show the reason why the employee is leaving, and should be sent to the employment department for entry on their record.

Shortages in Pay.—Whenever a workman charges that there is a shortage in his pay, the payroll department should be immediately advised on a form similar to Form 27. This claim should be accompanied by substantiating evidence in the form of "Department Credit and Time Records," which should be checked by the clerk in order that no invalid claims may be sent in. After investigation, the duplicate copy is returned to show the action taken. When it is found that an operator's claim for shortage is correct, the adjustment can then be made.

Transferring Employees.—If it is necessary to transfer an employee from one department to another, his card, Form 28, previously referred to in this chapter, with a memorandum signed by the foreman should be sent to the payroll department, stating the employees name and number, as well as the department to which he is to be transferred. Upon receipt of this notification, the payroll department will deliver a new card, bearing the new number assigned

FORM 27

CLAIM OF ERROR IN PAY—PAYROLL RECORD

OPERATOR NO.	NAME

CLAIMS ERROR IN PAY AS FOLLOWS

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.	TOTAL HRS	AMOUNT
DAY WORK									
PIECE WORK									

WEEK ENDING

DEPARTMENT

APPROVED BY

ADJUSTED WEEK ENDING

REMARKS

FORM 27

CLAIM OF ERROR IN PAY—OPERATORS RECORD

OPERATOR NO	NAME

CLAIMS ERROR IN PAY AS FOLLOWS

	SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.	TOTAL HRS	AMOUNT
DAY WORK									
PIECE WORK									

WEEK ENDING	TOTAL	
DEPARTMENT	PAID	
APPROVED BY	SHORTAGE OVER-PAY'T	
ADJUSTED WEEK ENDING	CREDITED DEDUCTED	

REMARKS

CLAIMS OF PIECE WORK OPERATORS MUST BE ACCOMPANIED BY PIECE WORK CREDITS

FORM 27. CLAIM FOR ERROR IN PAY

to the employee when this is necessary, to the department to which the employee has been transferred.

Accidents.—When an employee is injured while working in the shop, notification on Form 29 should at once be sent to the employment department. This report should contain all available evidence concerning the injury, and should be signed personally by the foreman. The operator's time ticket for the job on which he was working should be closed, a pass, Form 23, should be made out if it is necessary for the person to leave the building, and this pass should state that the person is leaving on account of injury, and whether he is going home or to a hospital.

FORM 28

CLOCK NO.________ NAME ____ DEPT.

WEEK ENDING	S.	M	T.	W.	T	F.	S	TOTAL HRS.	TIMES LATE	WAGES	WEEK ENDING	S.	M	T.	W	T	F	S.	TOTAL HRS.	TIMES LATE	WAGES
JUNE 3											SEPT. 2										
" 10											" 9										
" 17											" 16										
" 24											" 23										
JULY 1											" 30										
" 8											OCT. 7										
" 15											" 14										
" 22											" 21										
" 29											" 28										
AUG. 5											NOV. 4										
" 12											" 11										
" 19											" 18										
" 26											" 25										

FORM 28. EMPLOYEE'S CARD

It is usually the custom in factories to give the operators credit for all time lost on account of injury, and therefore no time ticket should be sent to the payroll department for any absence in such an event. A day-work time-ticket should be made out each day for all such time lost, and the time should be charged to the expense order-number designated for injury expense. Any time used in giving assistance to the injured person should also be charged in like manner.

Shop Clerical Inspection.—Owing to the large amount of detail that must be handled by the shop clerical staff, and also because of the ramifications of this work, it is the custom in most well-organized plants, especially those of the larger companies, for a corps of inspectors or instructors, scattered through-

FORM 29

ACCIDENT REPORT

Name,	Date,
Address,	Time,
Age,	Clock No.

Place of Accident,

Witnesses of Accident and Addresses:

Nature of Injury,

Full particulars of Accident

(Signed) Foreman

FORM 29. ACCIDENT REPORT

out the shop, to go over the work of the clerks at periodic intervals. Their object is both to investigate the accuracy of the work done by these clerks, and also to assist them in the way of offering suggestions that may facilitate or expedite their operations. There is probably no function of shop procedure on which more depends than the work of these foreman's clerks. There is also no phase of the work which is more involved, or which requires more clear-headedness and good judgment than the duties performed by these same clerks. They cannot be trained overnight; and much confusion can result where new

clerks have to be substituted who are not familiar with the shop procedure. It is therefore of paramount importance that they be carefully selected and encouraged in performing their respective functions.

It is not the usual policy of those writing on this subject of cost accounting to more than briefly pass over the work of the shop clerical force. I have found, however, in the course of quite a number of years of experience in connection with manufacturing, that the work done by this department of the shop organization can do much to help production if it is carefully worked out, and on the other hand, that all kinds of trouble may result if the importance of this work is not properly understood by the executives. In discussing the work of this department at what might be considered an undue length, I am laying myself open to criticism, but because of my convictions of this subject, I have deemed it necessary to cite the work of this department in detail in order that the student of shop management may thoroughly appreciate its significance.

CHAPTER VII

"MECHANISM" OF TIME-KEEPING

Compiling Payroll Statistics.—An analysis has been made in the preceding chapter of the way in which performance records pertaining to labor and materials are made. It is now necessary to study the different methods of collecting and assembling information so that it can be used for the purpose intended. The primary object of collecting time-records is that they shall be used in making up the weekly payroll of the factory. Let us consider, therefore, the way in which these payroll statistics are compiled and recorded, and the instructions incidental to this procedure.

After the time-slips for the week have all been received by the payroll department, the total time for each operator must first be checked against his in-and-out clock records, in order to safeguard against possible errors whereby more time may have been accounted for on orders than was actually spent by the workmen in the factory. This is necessary not only from the payroll department's point of view, but also from a cost viewpoint.

Accounting for All Time.—It does not necessarily follow that all the workman's time has been applied to productive orders, and that it will be all accounted

for in this way. The time-tickets will, however, show just how much time has been put on actual production work, and how much has been charged to expense in the form of idle time, or for work done on expense orders. It is therefore of vital importance that every minute of each workman's time be charged either against productive or non-productive order numbers, so that they will check up with the total in-and-out time for that period.

After these records have been checked up against one another by the payroll department, the total amount of the payroll for the week is then charged partly to the Productive Labor Account and partly to the Shop Expense Account, according to the extent of the charges incurred as analyzed from the time-tickets. A journal entry is then made, charging these accounts and crediting the Cash Account. While apparently this does not seem to involve the expenditure of very much effort on the part of the payroll department, if we stop to recall the work of the foreman's clerks in connection with the records that they make pertaining to defective work, bonuses, straight piece-work and other sundry data concerning the different forms of wage payment, we can gain a somewhat better idea of the scope of the work that has to be done by the payroll department, not only in checking these records against the in-and-out time of each operative, but also in computing the total pay and making the necessary deductions for lateness, time out, and so on.

In-And-Out Time.—Usually in-and-out time is recorded by means of the clock-card system, according

to which an employee on entering the factory inserts a card in a clock and, by pulling a lever, stamps the time of his arrival on the card. This operation is again performed when he goes out and comes in at noon, and also on leaving the factory at the close of the day. After stamping his card, he places it in a rack, which is usually fastened to a wall very near the clock. It remains there until it is collected by the payroll department. The same card is generally used for a period of a full week, but in a great many factories these cards are taken from the racks each day and checked up for latenesses or absences.

Why Record In-and-Out Time?—The purpose of recording this in-and-out is, first, to ascertain the exact time of arrival and departure of each workman; secondly, to check latenesses; and thirdly, to record absentees. Most of the large manufacturing plants have adopted the policy of docking the workman either fifteen minutes or a half-hour even if they are only a few minutes late. This is done with the object of instilling in the men's minds the importance of promptness, and it usually has the desired effect. Some factories have these in-and-out clocks located at the main entrance to the plant, instead of in the departments where the workmen are employed. Where this method is used, there is a tendency on the part of the workmen to loiter between the clock and their work-benches or machines, but this can be remedied by having the clocks placed in the departments. Figure 30 shows a typical in-and-out clock where the records are made on sheets. These clocks are so arranged that they can be set to print

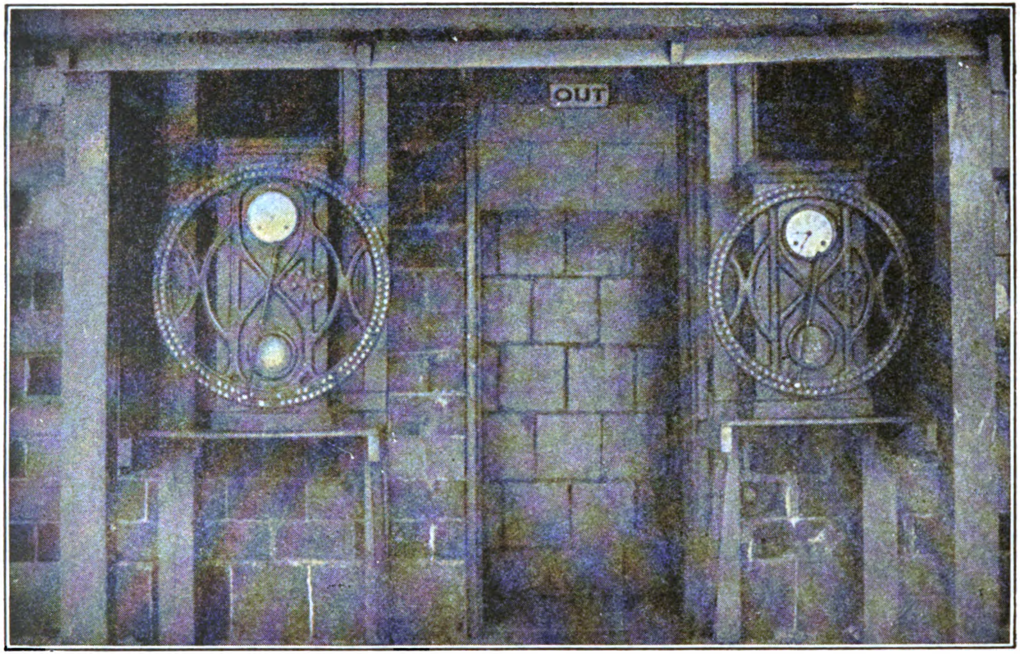


FIG. 30. IN-AND-OUT CLOCK

latenesses in red ink, so that tardiness will be self-indicative when the sheets are examined. After the sheets have been collected, the payroll department must enter this time in a payroll book, a sample sheet of which is shown on Form 31.

In some factories, it is the practice to check the time-tickets each day against these in-and-out time records, while in others this is done only weekly. When the operators are being paid on a straight day-work wage basis, this checking is not a very complex problem; and after the records have once been made to agree, the pay of each workman is simply his total time multiplied by his rate per hour or day, as the case may be. When, however, it is necessary for premiums or bouses to be figured, and when deductions for defective work have to be made, considerable more work is involved in making up these payroll records.

Payroll Summary Sheets.—Form 32 shows how wages are computed and extended each week by the payroll department. This is done in a different book from that in which the in-and-out time records are kept. Before it can be done, however, the payroll department not only has to check and verify the correctness of the calculations made by the departmental time-clerks on the time tickets, but the department must also check the wage rate per hour and the piece-work rate used in figuring every operation, job, or order.

This verification, while it involves a large amount of detail work, can be done quickly if the records of the payroll department are properly kept. For ex-

FORM 31

IN & OUT TIME - TAKEN FROM CLOCK RECORDS

Week Ending ____________

DEPT	EMP NO	NAME	MONDAY			TUESDAY			WEDNESDAY			THURSDAY			REGULAR			OVERTIME			TOTAL WAGES
			REG	O.T	TOTAL	REG.	O T	TOTAL	REG.	O.T	TOTAL	REG.	O.T	TOTAL	TOTAL HRS.	RATE	WAGES	TOTAL HRS	RATE	WAGES	

FORM 31. TYPICAL PAYROLL BOOK FOR USE WITH IN-AND-OUT CLOCKS

FORM 32

PAY ROLL WEEK ENDING ____________

EMP. NO.	EMPLOYEE'S NAME	RATE	HRS.	REGULAR DAY WAGES	OVERTIME			PIECE WORK EARNINGS	BONUS EARNINGS	TOTAL EARNINGS	DEDUCTIONS			NET EARNINGS
					Hours	Rate	Amount				For time out	For defect. work	Total	

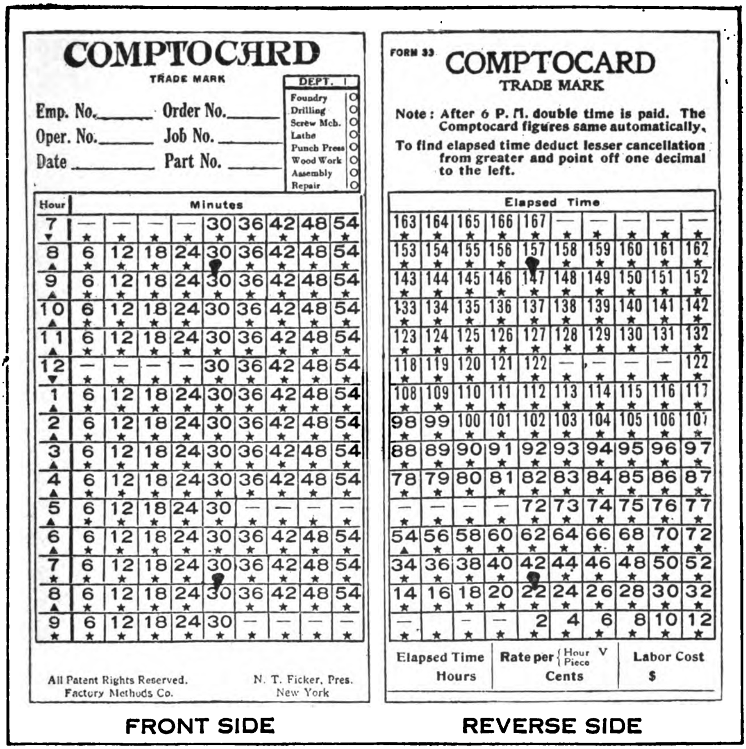
FORM 32. PAYROLL SUMMARY SHEET

ample, there should be a separate card showing the rate of each workman on both an hourly and a weekly basis, as well as the piece-work price on every operation worked on in the factory. In plants where bonus and premium systems are in use, the basis of remuneration should also be kept on file in such a way as to make it easy of reference. The standard rates of pay, extended so as to show the labor for any period of time at any rate of pay, should also be kept on file, so as to eliminate the necessity of computing each workman's earnings on a day-work basis.

It is not necessary to elaborate further the importance of maintaining adequate and up-to-date records for reference purposes in the payroll department. But unless these records are kept in a systematic manner, a chaotic condition entailing an endless amount of confusion cannot be long forestalled. Therefore, because of the fact that workmen's wages are continually being changed in a factory, and workmen are being transferred from one department to another, notices of such changes in wage payment or location of employee should receive the prompt attention of the payroll department, and the necessary entries should be made on the records to bring them up to date.

In order that the student of this question of labor cost finding may gain a somewhat better idea of the different ways in which time and cost records are made and compiled, it might be well at this time to consider some of the mechanical and other devices used in connection with the making of these records.

Semi-Automatic Time-Cards.—A system known as



COMPTOCARD
TRADE MARK

Emp. No.______ Order No.______
Oper. No.______ Job No.______
Date ______ Part No.______

DEPT.
Foundry
Drilling
Screw Mch.
Lathe
Punch Press
Wood Work
Assembly
Repair

Hour	Minutes								
7	—	—	—	—	30	36	42	48	54
8	6	12	18	24	30	36	42	48	54
9	6	12	18	24	30	36	42	48	54
10	6	12	18	24	30	36	42	48	54
11	6	12	18	24	30	36	42	48	54
12	—	—	—	—	30	36	42	48	54
1	6	12	18	24	30	36	42	48	54
2	6	12	18	24	30	36	42	48	54
3	6	12	18	24	30	36	42	48	54
4	6	12	18	24	30	36	42	48	54
5	6	12	18	24	30	—	—	—	—
6	6	12	18	24	30	36	42	48	54
7	6	12	18	24	30	36	42	48	54
8	6	12	18	24	30	36	42	48	54
9	6	12	18	24	30	—	—	—	—

N. T. Ficker, Pres.
New York

FRONT SIDE

FORM 33 COMPTOCARD
TRADE MARK

Note: After 6 P. M. double time is paid. The Comptocard figures same automatically.
To find elapsed time deduct lesser cancellation from greater and point off one decimal to the left.

Elapsed Time									
163	164	165	166	167	—	—	—	—	—
153	154	155	156	157	158	159	160	161	162
143	144	145	146	147	148	149	150	151	152
133	134	135	136	137	138	139	140	141	142
123	124	125	126	127	128	129	130	131	132
118	119	120	121	122	—	—	—	—	122
108	109	110	111	112	113	114	115	116	117
98	99	100	101	102	103	104	105	106	107
88	89	90	91	92	93	94	95	96	97
78	79	80	81	82	83	84	85	86	87
—	—	—	—	72	73	74	75	76	77
54	56	58	60	62	64	66	68	70	72
34	36	38	40	42	44	46	48	50	52
14	16	18	20	22	24	26	28	30	32
—	—	—	—	2	4	6	8	10	12

Elapsed Time Hours	Rate per Hour / Piece Cents	Labor Cost $

REVERSE SIDE

FORM 33. SINGLE JOB "COMPTOCARD"

the "Comptocard" method of labor cost finding is used by a large number of manufacturing plants in connection with making records of the time spent on each job to which a workman has been assigned in the course of each day while in the factory. This card, a specimen of the front and reverse sides of which are shown on Form 33, consists of a patented card on which the hours and fractional parts thereof

—in periods of tenth hours (six-minute periods)—are printed on one side of the card, and a computing table on the reverse side. When a workman starts a job, an ordinary deep-throated hand punch is used to punch the time started, and when he finishes a job the time is punched again. The elapsed time is found on the reverse side by subtracting the lesser number punched from the greater, and pointing off one decimal place to the left. This gives the result in hours and tenths of hours in decimals.

These cards are arranged so as to conform to the particular requirements in each factory where they are to be used, and can be arranged so as to allow for lunch and supper periods, and to compute overtime at time and a half, double time, or any other extra wage basis. Form 33 is a specimen of a "Single Job Comptocard," which uses a separate card for every job change. Form 34 shows this same method of computation applied to a card arranged to take care of several jobs in the course of a day. The punchings of starting and finishing times of jobs are clearly shown in the illustration, and the method of computing the elapsed time by making these simple subtractions will be readily seen. These cards are also arranged, in other cases, to compute directly the elapsed time and labor cost at a fixed rate per hour. Still other cards are used when more than one day's record is kept on a single card.

Some Special Devices.—Figure 35 shows a mechanical means of recording job time on a Follett job-time clock. This consists of a time-stamp which is operated by a clock mechanism. A card is stamped

Sears-Cross Company

Punch at start and completion of each job.

Hour	Minutes								
7	6	12	18	24	30	36	42	48	54
8	6	12	18	24	30	36	42	48	54
9	6	12	18	24	30	36	42	48	54
10	6	12	18	24	30	36	42	48	54
11	6	12	18	24	30	36	42	48	54
12	—	—	—	—	30	36	42	48	54
1	6	12	18	24	30	36	42	48	54
2	6	12	18	24	30	36	42	48	54
3	6	12	18	24	30	36	42	48	54
4	6	12	18	24	30	36	42	48	54
5	6	12	18			—	—	—	

Man No. ______ Date ______
Part No. 2946 Order No. ______
Oper. No. ______ Act. No. ______
Mach. No. ______

Man No. ______ Date ______
Part No. 3125 Order No. ______
Oper. No. ______ Act. No. ______
Mach. No. ______

Man No. ______ Date ______
Part No. 5541 Order No. ______
Oper. No. ______ Act. No. ______
Mach. No. ______

Man No. ______ Date ______
Part No. 3262 Order No. ______
Oper. No. ______ Act. No. ______
Mach. No. ______

FRONT SIDE

FORM 34

COMPTOCARD

TRADE MARK

Man No. 244 Date ______

Elapsed Time									
90	91	92	93	94	95	96	97	98	99
80	81	82	83	84	85	86	87	88	89
70	71	72	73	74	75	76	77	78	79
60	61	62	63	64	65	66	67	68	69
50	51	52	53	54	55	56	57	58	59
45	46	47	48	49	—	—	—	—	49
35	36	37	38	39	40	41	42	43	44
25	26	27	28	29	30	31	32	33	34
15	16	17	18	19	20	21	22	23	24
5	6	7	8	9	10	11	12	13	14
—	—	—	—	—	—	1	2	3	4

	Rate	Cost
Hrs. 1.5	20¢	.30
Pcs.		

	Rate	Cost
Hrs. 2.2	20¢	.44
Pcs.		

	Rate	Cost
Hrs. 2.2	20¢	.44
Pcs.		

	Rate	Cost
Hrs. 3.9	20¢	.78
Pcs.		

REVERSE SIDE

FORM 34. FOUR-JOB "COMPTOCARD"

on this clock by a clerk at the start and completion of each job. Gauges can be fastened to the top plate to act as guides for cards when they are being stamped. This device records the time by hour and minutes and can be equipped with decimal wheels to record the time in hours and decimal parts thereof. Form 35-a is a specimen of an in-and-out time record printed on card. Figure 36 and the accompanying forms show a "Calculagraph" and record cards, which is another means of mechanically recording the starting and finishing time of different jobs, and of indicating the elapsed time by means of dials and arrows. When a workman starts a job, the clerk stamps the ticket by throwing one of two levers by which this machine is operated. This operation prints the starting time on the card in the form of a dial with an arrow pointing to this starting time. When the imprint has been made on the card, the lever is then thrown in the opposite direction, thereby causing two separate dials without the arrows to be printed on the time-slip. The card is then put in a rack or file until the workman has finished his job, whereupon it is again inserted in the machine and the second lever is pulled, whereupon two arrows are printed within the two dials previously referred to. The position of these arrows indicates the elapsed time in hours and fractional parts thereof. Figure 36-a shows the calculagraph in use in a machine shop.

The Cost Meter.—The cost meter is an electric secondary clock connected with a master clock; the latter closes an electric circuit at periodic intervals. One of these secondary clocks is used by each opera-

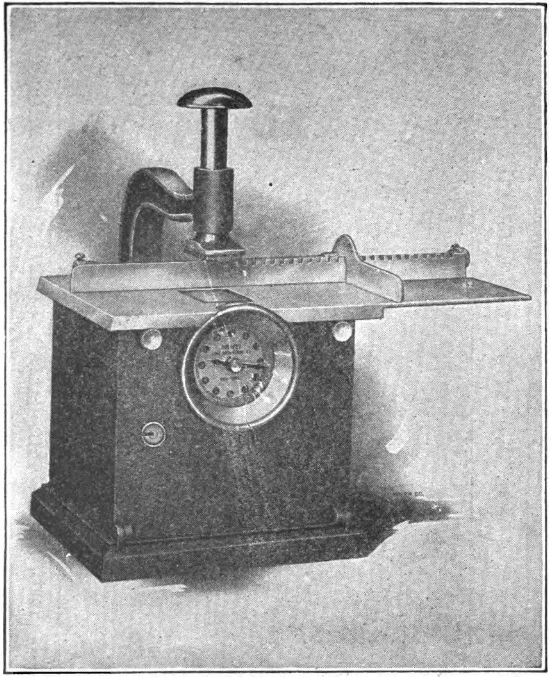
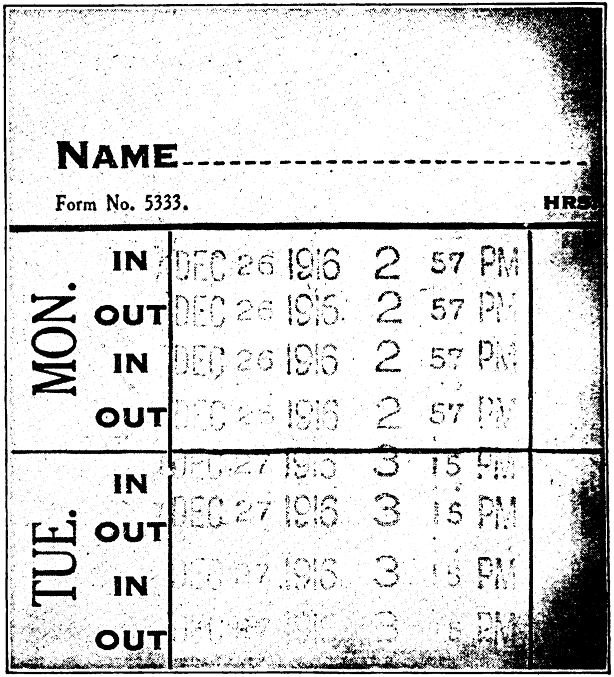


FIG. 35. FOLLETT TIME STAMP WITH GAUGE



NAME --

Form No. 5333. HRS.

MON.	IN	DEC 26 1916 2 57 PM	
	OUT	DEC 26 1916 2 57 PM	
	IN	DEC 26 1916 2 57 PM	
	OUT	DEC 26 1916 2 57 PM	
TUE.	IN	DEC 27 1916 3 15 PM	
	OUT	DEC 27 1916 3 15 PM	
	IN	DEC 27 1916 3 15 PM	
	OUT	[illegible]	

FIG. 35-A. SPECIMEN OF FOLLETT TIME RECORD

FIG. 36. THE CALCULAGRAPH

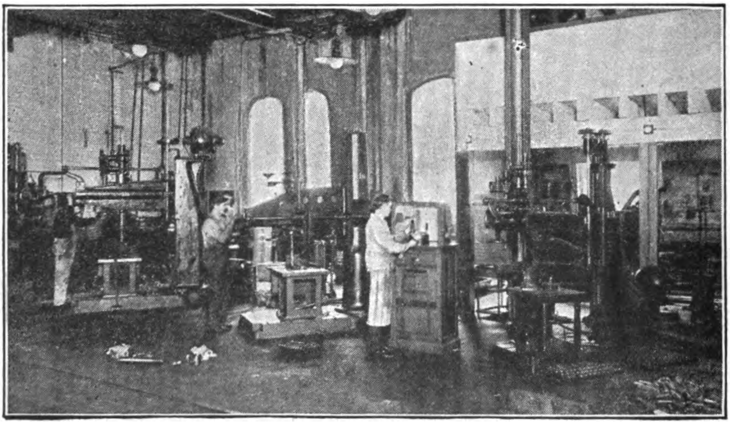
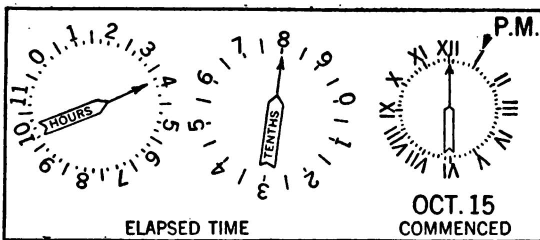
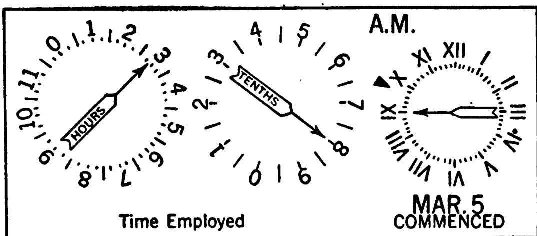


FIG. 36-A. THE CALCULAGRAPH IN THE SHOP



DEPT. A	
Emp. No.	75
Hours	3.8
Rate 40 Amt.	1.52
Order No.	444
Draw. No.	29-B
Mach. No.	27
Part No.	49
Pcs. on Order	150
Pcs. Finished	150
Pcs. Good	137
Pcs. Bad	13

Operation	Speed	Feed	Cut	Operation	Speed	Feed	Cut
Lay Out				Mill			
Chip				Plane			
Grind ✓				Shape			
Bore				Saw			
Drill				Expand			
Cut Off				Helping			



MACHINE SHOP	
Job No.	530
Workman No.	38

Boring	Drilling	Grinding	Planing	Tapping	Time Allowed
Chipping	Facing	Milling ✓	Roughing	Threading	Premium Credit
Cutting Off	Filing	Mounting	Shaping	Turning	Foreman

Quantity ______________ Total Time ______________ Rate ______________ Cost ______________

FORM 37. CALCULAGRAPH RECORDS

tor. It contains rolls of paper tape which, as the time elapses, are wound on another roll, the length of the paper so wound being the measure of the elapsed time multiplied by the workman's rate per hour. Each of these rolls of paper is removed from the machine and cut into pieces representing the cost of each job which the operator has worked on during that day. These strips of paper are then mounted on assembly sheets or cards; each space across the tape represents two dollars' worth of incurred cost. Different colors can be used to represent different departments of the factory. These machines are not sold outright, but are leased on an annual rental basis.

Bishop Calculating Recorder.—The Bishop Calculating Recorder, Figure 38, is a mechanical secondary device controlled by a master clock which transmits electric impulses at periodic intervals to the secondary apparatus, thereby causing it to move forward one notch, which is indicative of ten minutes' elapsed time. A specially printed card (Figure 38A) forms the basis of this method of time-recording. The worker inserts this special card into the recorder face down at the time of starting a job, and by pressing a lever causes a "V"-shaped cut to be made on one edge of this card.

When the job is finished, the workman re-inserts the card, but this time he must insert it face up. When the plunger is pressed another "V" is cut on the same edge of the card. The printed figure opposite the second cut indicates the elapsed time for that job. A separate card has to be used for each job worked on in the course of a day. These cards

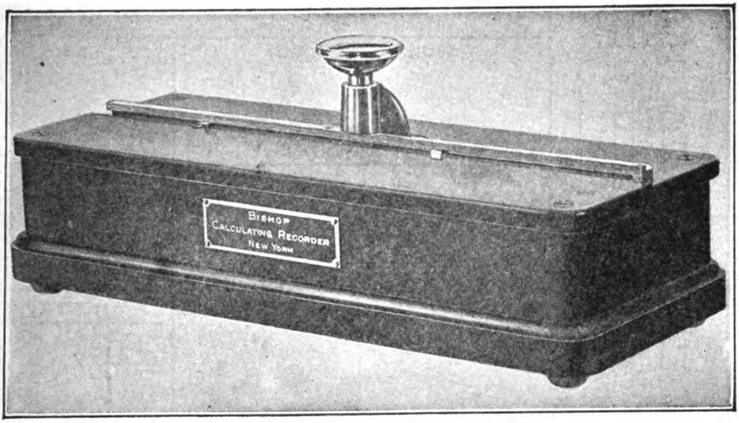
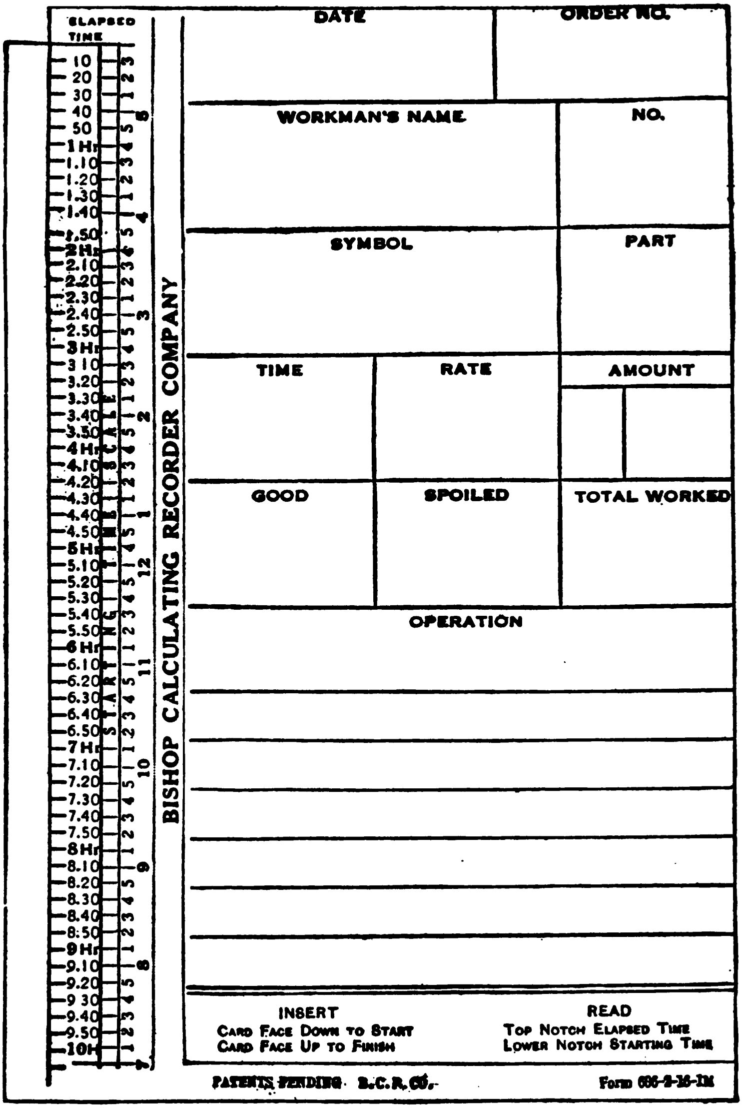


FIG. 38. BISHOP CALCULATING RECORDER

are collected daily and sent to the office, where a clerk posts the workman's rate per hour on each card, and by means of a wage scale ascertains the labor cost. He then posts this on each job card.

The Periodograph.—The "Periodograph" (Figure 39) consists of an electrically operated controlling clock, a panel board, and registers which are conveniently placed throughout the factory. The controlling clock and the panel board are usually placed in the office, and can be used to operate any number of registers. The controlling clock is used only for the purpose of sending the electrical impulses over the wires to the recording registers. The accumulating and recording of time is done by the registers, which are set at zero at the beginning of the pay period, and from then on count the time in tenth hour, twentieth hour, or quarter hour periods. The tenth hour period, however, is the most widely used


ELAPSED TIME

10 20 30 40 50 1 Hr 1.10 1.20 1.30 1.40 1.50 2 Hr 2.10 2.20 2.30 2.40 2.50 3 Hr 3.10 3.20 3.30 3.40 3.50 4 Hr 4.10 4.20 4.30 4.40 4.50 5 Hr 5.10 5.20 5.30 5.40 5.50 6 Hr 6.10 6.20 6.30 6.40 6.50 7 Hr 7.10 7.20 7.30 7.40 7.50 8 Hr 8.10 8.20 8.30 8.40 8.50 9 Hr 9.10 9.20 9.30 9.40 9.50 10 H

STARTING TIME SCALE

BISHOP CALCULATING RECORDER COMPANY

DATE		ORDER NO.
WORKMAN'S NAME		NO.
SYMBOL		PART
TIME	RATE	AMOUNT
GOOD	SPOILED	TOTAL WORKED

OPERATION

INSERT
CARD FACE DOWN TO START
CARD FACE UP TO FINISH

READ
TOP NOTCH ELAPSED TIME
LOWER NOTCH STARTING TIME

PATENTS PENDING B.C.R.CO. Form 606-2-16-1M

FORM 38-A. CARD FOR BISHOP CALCULATING RECORDER

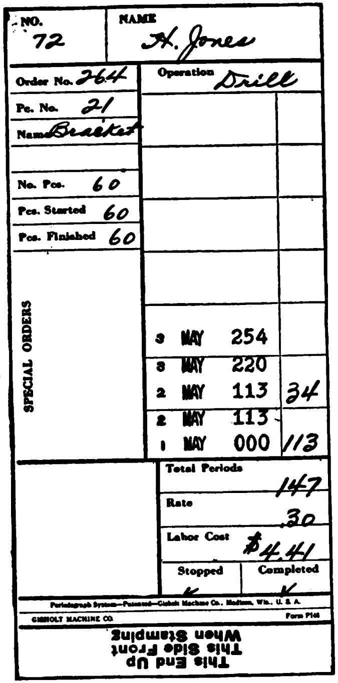


FIG. 38-A. CARD FOR THE PERIODGRAPH

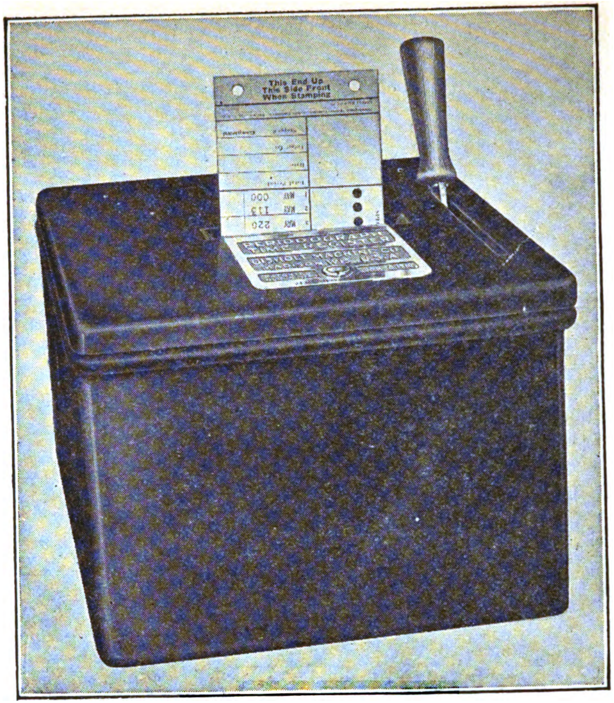
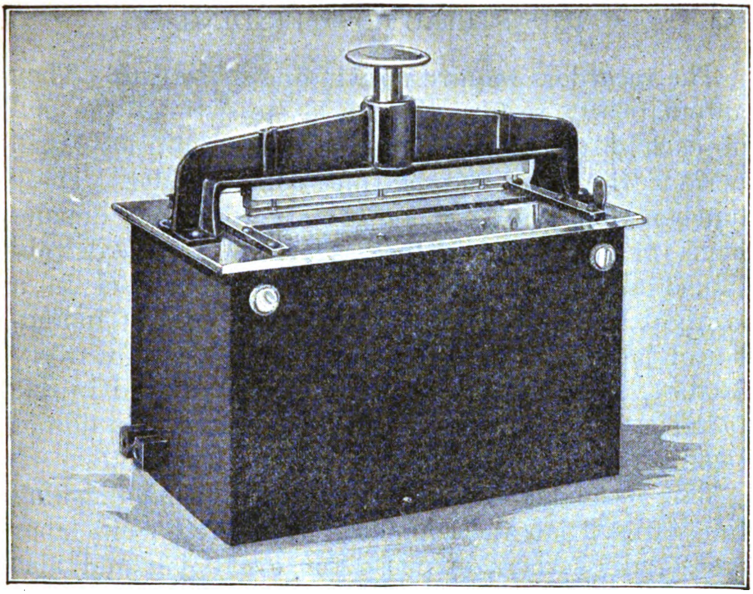


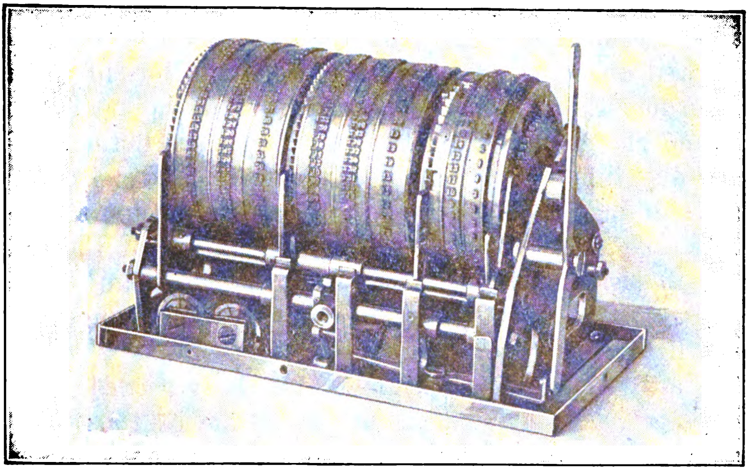
FIG. 39. PERIODGRAPH

on account of the advantage of figuring on a decimal basis. When the workman starts a job, he inserts the card (Figure 39A) in the register and by moving a lever prints the date and a period number on it. He repeats this operation again when the job is completed, or laid aside for other work. At the second printing a higher period number is stamped on the card, and the elapsed time is figured in the office by subtracting the lower period number from the higher. Overtime is shown by a mark (X) printed beside the period number.

The principle involved in this method is much the same as that of the Comptocard method of labor cost finding previously explained, except that the punching is done by machine, whereas in the case of the Comptocard the punching is done by hand. The difference is that one is a mechanical record and the other is not. However, in the case of the Comptocard method, which is non-mechanical, it is not necessary to have the workmen leave their benches at the start and the completion of each job change.

Ficker Cost Recorder.—The Ficker Cost Recorder is an individual time-stamp and cost-recorder for each workman in the factory. The mechanism of the recorder is controlled and operated by a master clock, which makes and breaks an electric circuit once every minute. The current—which is supplied by a small storage battery, only one being necessary for a whole plant—acting through an electro magnet in each recorder, gives the operating impulse. Figures 40 and 40-a show respectively the outside case of this recorder and the internal mechanism.





FIGS. 40 AND 40-A. THE FICKER COST RECORDER

The recorders require no winding or setting. They automatically restore themselves to zero at the end of each day, and also automatically subtract lunch periods from the elapsed-time computations. These lunch periods can be made to vary with each department or workman if necessary. The records obtained are in clear, bold-faced type, printed in a straight line and easily legible. The form of in-and-out or job-record card can be made different for every factory, or any number of forms can be used in one factory. The records made by these recorders do not require the use of any special kinds of cards.

This mechanism records the starting and finishing time of each job and computes the elapsed time, labor cost, and overhead expense for every job and also accumulates the totals for elapsed time, labor cost, and overhead for all jobs that each workman has worked on each day. As each workman has his own recorder, this method does away with the need for in-and-out clocks, since the workmen record their in-and-out time at their places of work and loitering is eliminated. By means of an interchangeable rate strip, a new strip can be substituted for the old one in less than one minute when a workman's rate of pay is changed. This also applies to changes in overhead rates.

Figure 41 shows a specimen of a daily record made by this recorder. The in-and-out time of the workman is shown on the top coupon, and the coupons from 1 to 5 inclusive show the starting and finishing time, the labor cost, and the overhead expense on four different jobs a man has worked on during the day.

Employee No. 241		Name Ed Smith				Date Dec. 8.		
IN & OUT RECORD	Time		LAST JOB RECORD Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Morning IN	7:00		00.00	$ 00.00	$ 00.00	00.00	$ 00.00	$ 00.00
Noon OUT	12:00		1.10	$ .23	$ .14	5.00	$ 1.00	$ .60
Noon IN	1:00		1.10	$ .23	$ .14	5.00	$ 1.00	$ .60
Night OUT	5:00		1.00	$ .20	$ .12	9.00	$ 1.80	$ 1.08
1	Order No. 2946		Job No. 596			Quantity 500		
Job Record	Time		Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Started	7:00		00.00	$ 00.00	$ 00.00	00.00	$ 00.00	$ 00.00
Finished	10:30		3.30	$ .70	$ .42	3.30	$ .70	$ .42
2	Order No. Idle		Job No.			Quantity		
Job Record	Time		Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Started	10:30		00.00	$ 00.00	$ 00.00	3.30	$ .70	$ .42
Finished	10:50		.20	$ .07	$ .04	3.50	$ .77	$ .46
3	Order No. 3233		Job No. 413			Quantity 360		
Job Record	Time		Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Started	10:50		00.00	$ 00.00	$ 00.00	3.50	$ .77	$ .46
Finished	2:10		2.20	$ .46	$ .28	6.10	$ 1.23	$ .74
4	Order No. 4291		Job No. 622			Quantity 75		
Job Record	Time		Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Started	2:10		00.00	$ 00.00	$ 00.00	6.10	$ 1.23	$ .74
Finished	4:00		1.50	$ .37	$ .22	8.00	$ 1.60	$ .96
5	Order No. 2747		Job No. 455			Quantity 250		
Job Record	Time		Elapsed Time	LABOR	Overhead	TOTALS Elapsed Time	LABOR	Overhead
Started	4:00		00.00	$ 00.00	$ 00.00	8.00	$ 1.60	$ .96
Finished	5:00		1.00	$ .20	$ .12	9.00	$ 1.80	$ 1.08

FORM 41. DAILY RECORD MADE BY THE FICKER COST RECORDER

Coupon No. 2 shows idle time. In the last three columns the cumulative totals for elapsed time, labor, and overhead are shown. While the form shown here gives one card of six coupons, the six can be on separate cards or paper slips if more convenient. When these records are received in the office, they

are complete and ready to be filed. The top coupon gives to the payroll department a record of the in-and-out time of the workman, while the respective job coupons are filed according to order number or job number as the case may be. All that is then necessary is that the tickets for each job be summarized when the job is finished.

Study of Conditions Essential.—I have endeavored to show by means of a comparison of the leading methods of time-keeping the different ways in which labor costs and overhead expense against jobs can be arrived at. A comparison of these methods will show that while they vary substantially in method of operation, this variation itself makes it possible to select the most practicable method for each specific plant under consideration. One method that is entirely practicable in one plant may not be so in another, and vice versa. It is of paramount importance that where a method of time-keeping is to be installed or where the method in use is to be changed, a careful study be made of the existing conditions in order that the most adaptable and efficient method may be used.

CHAPTER VIII

RELATION OF INSPECTION TO COSTS

Inspection Defined.—Inspection forms such a large part of the work incidental to determining the earnings of workmen when on a piece-work or bonus basis that I have chosen to discuss the question of inspection at this point. Inspection is defined as a careful critical investigation or scrutiny. In a manufacturing establishment inspection consists of two kinds—"general" or superficial inspection, and "analytical" or critical, respectively. In some plants, the mere scrutinizing of the material and workmanship will suffice, while in others a complete diagnosis of each article is necessary.

But an inspection made according to either of these phases, would only determine facts; whereas the value, as well as the object, of all inspection work is to utilize these facts in order to determine whether or not the material that has been inspected is satisfactory. The word satisfactory is a relative term, and in this connection satisfaction may depend upon the inspector's judgment, the judgment of some other person, or upon some pre-determined standard. The policy of some companies is to use samples as standards, while in other cases, specifications—either in writing or in the form of drawings—are used.

It is evident, then, that the objects of inspection is to determine whether or not the goods inspected are in accordance with these predetermined standards. The duty of the inspector is to see that the material is in accordance with the specified requirements, and that it is in all respects consistent with the standard established by either the specifications, drawings, or samples that he uses as a basis of comparison.

Special Features of Inspection.—There are, however, certain features pertaining to the goods under inspection which cannot always be reduced to a definite basis. The most prominent of these features is the quality of workmanship. For example, in connection with the finish of polished metal it would be most difficult to specify the exact degree of lustre desirable. Again, in the manufacture of telephone instruments, it would be most difficult to specify the volume of sound of the transmitters and receivers. In such cases, the best method of comparison is by means of samples.

One of the worst dangers to guard against in inspection work is the possibility of a conflict of opinion, as such differences inevitably result in delays, bad feeling, and general inefficiency. The nature of inspection therefore requires inspectors who are both intelligent and observing. The responsibility of accepting and rejecting material requires that they be honest and resolute, and the possibility of conflicts of opinion requires that they be tactful and polite, especially when in positions where they deal with people outside of the inspection branch of the company. Previous experience and technical training are

extremely valuable, but they are secondary to the preceding qualities, which are essential to the success of an inspector.

The scope of work done by the inspection department of a manufacturing company begins at the time when the raw material is first received in the factory, and continues until the finished product is delivered to the stock-rooms and warehouses of the company. The possibility of causing bad feeling on the ground that inspectors are not fair to piece-work operatives, requires definite specifications or drawings whenever it is possible to use them as a guide for measuring the quality of the work done by such piece-work operatives. In the case of raw-material inspection, this measurement can usually be reduced to a comparison of the material with specifications or drawings, and while constituting a large part of the work of the inspection branch of the company, does not involve so many complexities as are entailed after this raw material has once been worked on.

Main Divisions of Inspection.—The inspection work of a factory can usually be divided into the following main divisions—Raw-Material Inspection, Process-Inspection, Final Inspection, Tool-Inspection, and Laboratory-Inspection. Material should be inspected in the department that delivers it or at some location as near that department as possible. In the case of process and final inspection, the inspectors are divided into groups, each of which is under the supervision of a group-inspector.

These groups of inspectors are held directly responsible for the inspection of all material passing

through the inspection rooms under their supervision. Each of these groups is further subdivided into two classes, one known as "detail inspectors," who inspect every part or piece of a lot of material, and the other known as "general inspectors," who inspect that class of material in which the inspection of a comparatively small proportion is usually sufficient. This is especially true in the case of raw materials. The detail-inspectors are usually organized into small units or gangs of such a size that one person in charge, who reports to the group-inspector, can properly assign the work, instruct the detail-inspectors, and check the inspection. The maintenance of suitable inspectors as gang bosses and general inspectors is one of the vital features of every inspection system.

Head Raw-Material Inspector.—The work of the raw-material inspection division includes the inspection of all material purchased for manufacturing purposes. In some plants this is known as "purchased-material inspection," but the term "raw-material inspection" covers the greater part of the work and distinguishes it somewhat better from the other divisions. All raw-material inspection work should be done either in the receiving department or as near it as possible. The organization of the raw-material inspection division consists, first, of a head raw-material inspector, under whose supervision all purchased material is inspected. Besides the general supervision of the work, it is the duty of the head raw-material inspector to see that proper specifications for inspection are received and that they are arranged in proper form for the use of his inspectors.

He receives and investigates, either personally or through the agency of one of his men, all complaints pertaining to raw material. When it is necessary to make complaints to the shipper, he should send a typewritten report of the case to the general inspector, who will forward it to the purchasing agent for adustment. Where there is a large amount of raw material to be inspected, an assistant to the head inspector looks after the routine inspection work of all general inspectors, and gang bosses supervising detail-inspection work report to him.

Inspection Sometimes Omitted.—The purchasing department should send copies of all orders to the raw-material inspection divisions, as well as to the receiving department. The copies for both departments should be first sent to the head raw-material inspector, who stamps them either "To be inspected" or "No inspection," according to whether or not he wishes to have the material delivered to him for inspection. When no close limits are required, and when there are no frequent defects of a serious nature, such as those found in the case of commercial brass or iron, inspection is usually omitted. An occasional lot of such material is inspected as a matter of precaution, and if any serious trouble should develop in connection with it, inspection is made until the trouble has been overcome. Practically all material that has special requirements, close limits, or defects of frequent occurrence, is inspected.

All raw material, when received by the receiving department, is therefore delivered either to the raw-material inspectors or to the store-rooms, according

to whether the order has been stamped "To be inspected" or "No inspection." If no inspection is required, it is immediately sent to the store-rooms. In the case of material which requires inspection, reports are made by the inspectors, and copies are sent to all departments concerned. The head raw-material inspector should keep a record of all inspection work, classified according to maker and class of material.

When defective material is discovered, this is held by the raw-material inspection division until shipping instructions or notifications that it cannot be used, are furnished by the purchasing department. This defective material should be kept separate from all other material in process of inspection, and should be made easy of identification by means of tags attached to it. When the purchasing department receives notification that the defective material cannot be returned to the manufacturer, it is either junked or used to the best advantage, according to the judgment of the head raw-material inspector. In deciding such a question, he should consult with either the general foreman or the chief inspector. For material to be returned, shipping tickets are made out according to instructions from the purchasing department, and the material is then delivered to the shipping department.

Determining the Kind of Inspection.—In deciding whether or not material should receive general or detail inspection, and what the nature of the inspection shold be, the following points should be given careful consideration by either the head raw-material inspector or his assistant.

1. The method of manufacture before delivery to the company. The important factor here is whether or not the process is such that each individual part may have individual defects, or such that a defect of one part will be found in a large number of others. An example of the former case is the finish of moulded rubber parts, in which the finish may vary somewhat with each part; while an example of the latter would be that of drawn brass, in which the shape of this drawn stock is determined by the form of the die through which it is drawn. Moreover, a worn or incorrect die may affect a large quantity of material.

2. The manner in which the material is to be used in the factory, and the requirements of the finished output. The important factor here is whether or not a small percentage of defects will be sufficiently objectionable to justify a detail-inspection.

3. The value of the individual parts. If each part is of considerable value, a detail-inspection is usually justified, even if the percentage of defects is small.

4. The reliability of the manufacturer with reference to uniform quality of output. This usually resolves itself down to a question of inspection on the part of the manufacturer, and in most cases must be judged by past experience with his material.

General Inspection.—In practice, general inspectors are given instructions to watch particular classes of material that are not given a detailed inspection. The classes of material are divided among these inspectors. The nature and amount of inspection depends upon the kind of material and the require-

ments. For example, companies manufacturing brass or iron generally give this material such a close inspection in their own plants that the number of defects that a further detailed inspection would reveal would not warrant the expense involved. Furthermore, it is usually the practice of these manufacturers to replace any defective material found in stock.

Another illustration of determining whether general inspection alone is required, is in the inspection of commercial screws which are simply checked for maximum size on the pitch and root diameters by the use of a set of standard female thread-gauges and pitch micrometer calipers. The outside diameter is checked by the use of an ordinary micrometer caliper. Trouble is rarely experienced with the root diameter, since the threads in tap holes are never full. Screws are allowed to vary a certain amount under size, but rarely over size. In such an inspection as this, a small percentage of defects is usually permissible, and only a comparatively small quantity of any lot is inspected.

Detail Inspection.—The material that is given regular detail-inspection is usually material that must lie within special limits or meet special requirements. Examples of this class of material are cold drawn Norway iron, fuse wire, copper wire, moulded rubber parts, and fibre. Where material such as sheet metal, brass rod and tubing, copper wire, felt, and Norway iron is used in large quantities, written specifications and drawings are usually used.

Incidentally, it is well forth mentioning that this information, especially that pertaining to limits, is of

great value to men in the factory organization other than the raw-material inspectors. For example, it enables the drafting department to make its drawings so that the material can be used to the best advantage and will be interchangeable, and also makes it possible for the tool-designing department to design its tools for the most economical use of the material. It gives the gauge-designer the necessary information to make the requirements of his gauge agree with the requirements of the raw material, so far as is consistent with interchangeability and good workmanship. For the checking of dimensions, a considerable number of gauges and micrometer calipers are required. These are furnished in most cases by the Tool Inspection Division of the inspection department.

Sample Material for Tests.—Vouchers are approved for quality of material by the head raw-material inspector or by his assistant. When there are defects, the total number of such defects is specified on the form used. Whenever new material is ordered by the purchasing department, or when the source of supply of material previously used is changed, samples should be sent for approval. Unless the head raw-material inspector feels confident that he is qualified to pass judgment on these samples, they should be carefully tested in the shop. When any considerable quantity is to be ordered, the inspection department usually recommends that a small amount of material be furnished, sent through the operations in the factory, and assembled as part of the finished output. This is done in order to be sure that there

are no defects which the inspection of a few samples would not reveal, but which might develop in the course of manufacture. Experience has shown that this is a wise precaution. After such samples have been inspection and tested, a report is sent to the purchasing department through the office of the chief inspector. A change in the source of supply of any material should not be made without the approval of the shop superintendent. If such samples are approved the reports are sent to the shop superintendent for his approval before being delivered to the purchasing department.

Copper Wire—An Illustration.—In order to have a few illustrations of raw-material requirements, let us take, for example, a case of copper wire which has to conform to very small size limits. Very often the limitations confine the maximum variation to plus or minus .0001 of an inch. When we stop to consider that this is less than one-tenth the diameter of a human hair, the difficulties of measuring accurately dimensions of this kind will be readily appreciated. A measurement of this kind is the smallest that can be made with an ordinary micrometer caliper having a vernier attachment, and often because of personal and other errors, it cannot be relied upon. A large barrel micrometer caliper reading directly in .0001 of an inch is usually used for measurements of this kind. Aside from the difficulties of making a single accurate measurement, there are possibilities of the wire being elliptical or irregular in cross-section, and also of its diameter varying at different places in its length.

The best precaution against these latter conditions

is to purchase wire only from those concerns which themselves carefully inspect the wire as it is being drawn, since it would be very expensive for the inspection department of any factory to have to unwind wire of this kind from spools in order to measure and inspect its entire length. In inspecting wire of this kind, it is usually found that the condition of the first ten feet of a spool is a fair indication of the remainder. This brings us then to a consideration of just how important such an inspection would be in the case of the factory where the wire is made, and where the workmen who draw the wire may be paid on a piece-work basis. A maximum or minimum variation of a few thousandths of an inch does not seem very serious to the lay mind, but it is often a very serious and important problem in certain classes of manufacturing work, especially in such cases where the copper wire may possibly be used for electrical purposes.

Effect of Small Variations.—To see clearly the necessity of such fine limits, let us follow up the effect of these limits in the shop. In one case which we will take as an illustration, this might mean a variation of 3 per cent in diameter. Since the electrical resistance varies with the square of the diameter of the wire, this would mean a variation of resistance per unit of length of 6 per cent plus or minus, or a total possible variation of 12 per cent. A variation of 4 per cent in conductivity for fine copper wire is required by the manufacturers, which brings the total up to 16 per cent. On very small wire of comparatively soft metal, the process of insulating may slightly decrease

the diameter and cause variations of the resistance, which in some cases might amount to as much as 5 per cent or more.

Carelessness in winding, causing lack of absolute uniformity of tension, may also bring about variations of 5 per cent in resistance, making in all a total possible variation of 26 per cent of the required resistance. The operating requirements of an electrical instrument must be based on the minimum number of turns of wire that can of a certainty be wound on a spool without getting it too full. Now, when we stop to consider that there are other unavoidable variations affecting the resistance and the turns of wire—such as variations in the thickness of the insulation—we can see that this variation of 26 per cent in the resistance per unit of length of wire might make it impossible to fit the entire length into the required space allowed for it.

I have simply referred to a specific technical phase of manufacturing, as in the case of the wire illustration, to point out the importance of adequate inspection methods at the source, and to show where the workmen cannot be held accountable for what—in an instance of this kind—would amount to defective workmanship. A wire-drawer who was paid on a piece-work basis, and who through carelessness in observing instructions did not produce wire of a required gauge, would, in a case of this kind, therefore be held accountable for the loss which to a certain extent had been so incurred through his carelessness.

Where Many Inspectors Are Needed.—In some industries where interchangeable parts are required, a

large number of inspectors are neecssary in order to insure the absolute interchangeability of all parts. This is especially true where one thread has to fit over another, which is so general in the machine and tool industry. In such cases it is necessary to gauge every part for all important dimensions, in order to avoid serious complications. The process-material inspection division of the inspection department follows very closely the lines of the manufacturing departments. The fundamental principle of process-inspection is that after each manufacturing operation sufficient inspection should be made to determine whether or not the work has been properly done, and to allow only good material to pass on for further operations or to be delivered to the store-rooms. The foreman is held responsible for the work, and is expected to deliver material with only such defects and such a percentage of defects as would reasonably be expected from a first-class operator, provided the machinery, tools, and material are in excellent condition.

Process-Inspection; Counting.—It is not always necessary to have inspectors in each manufacturing department, but it is important to have them located so as to receive material from as many departments as can be arranged for without interfering with the work of such departments. This inspection work is usually done in counting rooms, where part of the work consists of inspecting and the rest of counting. All material is first received by the inspectors and then turned over to the "counters," who send them to the department or the store-room, as indicated by the routing ticket attached to the

material tray or to the material itself. The method of handling material and of keeping records throughout the shop should be so arranged that after each manufacturing operation the material is delivered to the inspectors, except when this inspection or counting for several operations can be properly done at the same time, on the completion of the last operation. The organization of the process-inspection division consists of a head process-inspector, a routine-inspector, to whom the group-inspectors report, and who supervises the routine inspecton, and a complaint-inspector, whose duty it is to investigate and take care of complaints from the foremen. Where the volume of work is sufficiently large, this duty is further delegated among supervising inspectors and group-inspectors. These groups are divided, as in the case of raw-material inspection, others including general and detail-inspectors.

Destination Cards.—All material should be delivered to an inspection room, accompanied by the proper form of destination card. When one lot of material is delivered in more than one receptacle, each receptacle should be accompanied by a separate destination card, or an identification card specifying to what lot it belongs. These destination cards should give, or refer to, sufficient information to allow of the proper inspection of the material that they accompany. This information usually refers to some drawing or specification. The inspector then inspects the material according to the information received, fills in a notification of the amount of defective material, and signs his name in the proper

place. Inspectors should not be allowed, under any circumstances, to change or make additions to the destination card except in those places where it is their duty to fill in data.

If errors are discovered, these destination tickets should be taken back to the foreman's clerk, or to any other duly authorized person who originally made them out. The material should be held in the inspection room until such errors are corrected. If the material is held for any considerable length of time, it should be reported to the chief inspector's office, who makes out and sends to the proper authorities a daily report of all material held up anywhere by the inspection department on account of errors, lack of information, and so on. Every inspector should be provided with a special stamp with his own name on it. No material should be received by counters of the inspection department unless the destination card is stamped with the name of the inspector who has passed the material. This inspector is held responsible for whatever a general inspection shows.

Records of Defective Material.—In order that the general foreman, the chief inspector, the shop superintendent, and others may be informed of the amount of defective material being made throughout the shop, suitable records should be kept as follows:

An inspection card should be made out for each lot of material inspected. This card is made out by the inspector, and shows the order number, whether the material was given a detailed or general inspection, the total quantity of defects, and a detailed list of the various defects, stating whether the defective ma-

terial is to be repaired or junked, and the departments responsible for the defects.

This inspection record is sent with the material to the counters, who enter the quantity of good material, and hold the record until it is collected and forwarded to the report clerks and the inspection department. From these inspection records the report clerks make up daily reports for each department, showing for each lot of material inspected in detail the total quantity and the various defects.

For material given a general inspection only, the total quantity is reported, in order that the quantity and percentage of defective material for the department may be calculated. Copies of these reports should then be sent to the foreman concerned. From the reports a weekly summary is made up for each department, a copy of which should be sent to the shop superintendent.

Worked Material.—General inspection of worked material such as punchings, small screw-machine parts, and the like, is carried on in much the same way as explained under the raw-material inspection discussion of general inspection. The amount of detailed inspection necessary depends very largely upon the foreman and his workmen. If the work is properly and carefully done, a great deal of the material will have so small a percentage of defects that a detailed inspection is not worth what it costs. On new jobs, and when inexperienced workmen are taken on, the amount of detailed inspection required should be increased, on account of possible misunderstanding of requirements or poor workmanship.

In a large manufacturing plant with which I am familiar, the total quantity of parts manufactured each month amounts approximately to fifty million. Of this total quantity, about 25 per cent are inspected in detail, and the balance are simply given a general inspection of the kind already outlined.

Final Inspection.—While I have explained in a general way the functions of the raw-material and process-inspection divisions, there still remains to be considered the final, tool, and laboratory inspection. The former includes the testing of all material manufactured, and this inspection work has to be done before the material is finally delivered by the shop for shipment or storage. The final inspectors are located in groups—usually one group being assigned to each assembly department, and located on the same floor with it.

A certain space convenient to the elevators and having proper light should be set aside for these inspectors and should be properly fitted with the necessary testing aparatus. The system of making the final inspection in the department where the finished material is assembled avoids the delay and injury from handling involved when all finished material is delivered to one place. This, however, requires more inspectors who can be depended upon to work independently, and is somewhat more expensive. Experience, however, has shown that this method of inspecting finished merchandise is the best in the long run.

This division of the inspection department is under the supervision of the head final inspector. All

finished material is given a detailed inspection, which is often supplemented by a further general inspection before the material is finally shipped. The general routine of this division is much the same as that of the process inspection, so it will not be necessary to elaborate on this point. As a general rule, the final inspection should be made along the following lines:

1. Shop order; to insure that the material is what the shop order calls for.
2. Mechanical features; to insure that the parts are correct ones, properly made, assembled, and adjusted.
3. Electrical or other features; to insure that all electrical, hydraulic, or other requirements are satisfactorily conformed to.
4. Finish and general appearance; to insure that the finish is according to requirements, and that the general appearance is workmanlike and satisfactory for the class of material inspected.

In addition to the required detail-inspection, every lot of material should be checked by the inspector in charge of that class of material, and the ticket should be stamped by him in the same manner as that prescribed for process-inspection routine. In the case of this final inspection, the detail inspectors are very often provided with small steel stamps, whenever practicable. Each inspector has a stamp with his own symbol, and makes his imprint at some suitable place on the article inspected, so that it can be referred back to him if the occasion demands. A record should be kept of these symbols, showing to whom they are assigned.

Tool-Inspection.—This covers the inspection of all tools, including gauges and testing equipment. The

tool inspectors are usually located in close proximity to the tool department, in order to facilitate deliveries, especially in the case of repaired tools, which are often urgently needed. All tools should be inspected according to the tool drawing and the drawings of the parts for which they are used; reference is made to assembly drawings when necessary, to determine important points. The inspector should also satisfy himself that the tool is in operative condition—that is, that it will operate satisfactorily. In this connection, mechanical features affecting operation (such as burr grooves, chip clearance, sharpness, temper, fit to machine or place where used, etc.) must be considered. In many cases, this requires that samples operated on by the tools be obtained and inspected. Partial assemblies should be made whenever they are necessary in order to decide whether the tools are satisfactory.

In certain departments where machine types such as punch presses and drilling machines are used, and where the wear on the tools is rapid and the error in size resulting therefrom difficult to detect, it has been found advisable in many cases to have a tool-inspector inspect all tools when returned to the department tool room, or periodically in the manufacturing departments if they are in continual use.

The general routine of the tool-inspection division is the same as that of the process-inspection; but since details, of course, are different on account of governing conditions, a card catalogue of all gauges in the factory should be kept. These cards should give a description of the gauge, name of the person

to whom it was assigned, period of inspection and so on. By "period of inspection" is meant the interval that may safely be allowed between inspections of the gauge in use. The periodical inspection of all gauges at frequent intervals, is a very vital feature of the entire inspection system.

Laboratory Inspection.—The laboratory inspection usually involves the maintenance of either a physical or a chemical laboratory, or both, each of which attends to the class of work indicated by its name. There are four general classes of work done by these laboratories.

First, the checking and standardizing of all testing instruments and apparatus in the factory. This is accomplished by keeping a card file of such apparatus and equipment, and periodically re-calling it for test. When it is not practicable to send the apparatus to the laboratory, a man is usually sent out to do whatever is necessary.

Second, making such tests for the other divisions of the inspection department as require laboratory equipment. An instance of this is found in the case of injectors used on locomotives. These injectors have to be subjected to high-pressure steam tests before they can be finally passed on. It very often happens that a piece of apparatus of this kind which apparently seems perfect, will develop defects due to strain which will render it absolutely useless. Another illustration is that of making tests on electroplating.

Third, making such final adjustments on the manufactured product of the factory as require special

laboratory equipment. This is especially applicable to the production of galvanometers, volt and ammeters, thermometers, and other manufactured articles of a like nature.

Fourth, the work of the physical laboratory also includes the testing of the hardness of materials, the torsion or twisting strength of metals, the running of tests to determine the amount of wear that parts will sustain, and any other functions of like nature which will aid the various divisions of the inspection department as a whole in performing their respective duties.

Importance of Inspection Department.—From the foregoing outline of the work of the inspection department, it will be seen that by virtue of the close acquaintance which this department has with all phases of manufacturing work being done, it can render service in a great many ways to the executives of the company. For example, it can make many suggestions and recommendations which, because of different viewpoint, may escape the attention of the department foreman where the work is done. It can also co-operate with other departments in investigating customers' complaints and unusual conditions shown by the defective-material reports, and can make periodic investigations that will be conducive to a more efficient state of production.

Generally speaking, the inspection department is well fitted to do this work, on account of the knowledge attained from continual inspection. As a general rule, however, the foreman concerned is also consulted concerning such matters. Whenever pos-

sible the inspection department should assist, by making recommendations, in standardizing the various operations performed in the shop, as regards both methods and quality of workmanship. Very often the drafting department of a manufacturing company will set limits that are entirely impracticable. Here again, the inspection department can co-operate in pointing out the reasons why alterations should be made in the specifications. When no limits are specified, the drafting department, the foreman, and the inspection department do not always agree. Also, quite often the individual operator working on a piece-work basis seems to think that he should be the judge, and consequently the results are frequently disastrous. A co-ordination along this line would therefore help to remedy such a condition.

Disposition of Material Outside of Specification Limits.—The problem of disposing of material that is outside of limits called for, is one of the most difficult problems to contend with. This is especially true in a shop where the aim is to deliver only the highest grade of quality and workmanship. The problem that confronts the inspector in cases of this kind is something like this: A box of material has been laid aside by the individual inspector as outside the limits which he has been instructed to allow. He refers this matter to his superior. A man from the office, who is responsible for the movement of this material, stands near with a worried expression on his face, and asks, "Is it junk, or is it material that we can use to make the shipment we have promised for today?" Perhaps the customer is becoming im-

patient for his goods. This represents the question in very acute form.

The answer is a matter of judgment which must be decided for each particular case. If the variation is such as to affect the ultimate use that is to be made of the finished output, the material of course cannot be used. On the other hand, if it is only slightly beyond the limits, then consideration should be given to the relative importance of the point in question as to the standard of workmanship as a whole. If it is insignificant by comparison, and especially if the point in question is expense, it is usually advisable to allow this particular lot of material to be used. The greatest objection to doing this, however, is the danger that the workmen will take such procedure as a precedent, especially when they are on piece-work, and will in the future expect less careful inspection than they have been accustomed to. It is, of course, the foreman's as well as the inspector's duty to see that this is not done. Such a deviation from the prescribed standards is permissible only in very urgent cases and when the customer is notified of the facts and agrees to assume the responsibility.

This is mentioned here simply in order to bring out one of the possible exigencies that have to be considered from the viewpoint both of inspection and of piece-work wages. In such a case as this, a workman would naturally have to be allowed full credit on work that otherwise would have been rejected. This necessarily involves making a special record of the case in order that the payroll department may not

be held to account by the workman at some future time when he is docked for the rejection of work of a similar nature.

Organization Essential.—A careful study of tne interlocking relations between the inspection and other departments of a manufacturing organization, as well as an appreciation of the extent to which the payroll department has to rely on records made by the inspection department, will show how important the work of this department is. A lack of organization of the inspection department can cause considerable bad feeling, and can do more to disrupt the general efficiency of a factory than almost anything else incidental to manufacture. On the other hand, organization can promote a feeling of confidence on the part of the workmen that they are being treated fairly, and in this way can do much to harmonize the work of the various departments, and thereby greatly increase the quality and the quantity of the output.

CHAPTER IX

PURCHASES AND STORES ACCOUNTING

Delegating Purchasing Authority.—Aside from the provision of a suitable place for the enactment of manufacturing work, the first function performed by any manufacturing business is that of securing the materials and equipment necessary for carrying on the work. This means the supplying of the necessary wants for the business through the medium of purchases. The first step in any stores-accounting system is therefore that of standardizing all matters pertaining to purchases, in order that all possible factors of waste may be eliminated. This immediately introduces the question as to how these purchases are to be made, what provision is to be made in the form of specifications, and so on, to serve as a means of control over the quality and quantity of all material purchased, the storing and issuing of this material on authorized demand, and finally the accounting procedure incidental thereto.

The most important point to be considered in connection with the first question—i.e., how these purchases are to be made—is the delegation of authority for making these purchases. It is a lamentable fact that the purchasing system in most manufacturing companies, as well as in practically all lines of

business, is carried on in a manner anything but efficient. This is due mainly to the fact that there is no central means of control over every kind of purchasing, and the result is that waste occurs in almost every stage where proper means are not provided for exercising control. Except when all purchasing is done through a duly authorized purchasing agent or department, and when this department can be held directly responsible, not only does waste occur, but confusion as well. This is especially true in all instances in which the heads of various units of a manufacturing business are permitted to do their own purchasing, and simply call on the purchasing department for such material or other supplies as they may not feel inclined to bother about. While on first consideration this does not seem to be a serious defect in a manufacturing organization, it should be kept in mind that wherever responsibility of any kind is divided the troublesome factor of shifting this responsibility from one head to another is immediately introduced.

Centralized versus Decentralized System.—In order to present a concrete illustration of the confusion that inevitably results where a central system of purchasing is not followed, let us consider such a typical illustration as that of the system in use up to a short time ago in New York City, as compared with a centralized system of purchasing as followed by the Canadian Pacific Railway Company of Canada.

There are 120 different departments, bureaus, boards, commissions and offices under the government of the City of New York, in whose various chief

executives is vested the power to purchase supplies. According to a report issued by Comptroller William A. Prendergast, the result of this system is that in no two of these 120 divisions are the methods and customs the same, and therefore no uniform system of making, recording, and accounting purchases is followed. Each department is a law unto itself and proceeds in utter ignorance of what other departments are doing. Each department keeps its own records and approves its own bills for payment. There is no central means of control, with the result that the city is buying annually at retail millions of dollars' worth of supplies which, if grouped together, could be purchased at wholesale prices or possibly even at less. When a system of this kind is in use, the possibility of putting into operation even the most elementary fundamental principle of purchasing,—whereby a reduction in price results from orders in quantities,—is impossible of application; and the condition resulting from such a system, which is not only archaic, but grossly wasteful and hopelessly inefficient, becomes readily apparent.

Under the centralized purchase plan used by the Canadian Pacific Railway, over $80,000,000 worth of supplies are purchased annually with absolute control over every item of purchase; and through the medium of centrally located storehouses, adequate control is maintained over all stocks necessary to supply a railroad extending over 12,000 miles. This is accomplished, not by a complex system of purchasing and accounting procedure, but by a method which is much simpler and which is conducive to much

greater economy than can be approached by any decentralized system of purchasing and stores-keeping.

The Comptroller of the City of New York proposed just such a system as that in use by the Canadian Pacific Railway, and has recommended that the purchasing agents scattered among these various organization units be grouped in one department under the executive control of a general purchasing agent, who will be responsible for every item of purchase made in the course of his term of office. Such a system as this would not only make possible a large saving in the cost of purchases, but would also be conducive to a co-ordination of these various units impossible under any other system.

The object of an efficient purchasing system is the unification of all purchases in order that gross quantities of materials and supplies may be purchased at minimum unit prices; a daily control by means of budget authorizations in order that the extent of these purchases may be curtailed where necessary, before they have exceeded the budget appropriations; and a reduction in the number of vouchers for payment of purchases resulting from larger single orders.

Open-Market Authorization.—One of the greatest defects of our modern purchasing systems is that they make use of what are known as market orders, whereby the heads of various units of a manufacturing or other business organization are authorized to make purchases not exceeding a specific amount. This system originated from a demand to find some means of meeting emergency requirements and, while in itself—when carried out in accordance with the

original intention—cannot be objected to, the abuse of this open-market authorization policy calls for the absolute elimination of it in any efficient and well-organized purchasing plan. In the City of New York, this open-market order privilege permitted department heads, without competition, to make purchases not exceeding $1,000 at any one time. The result was that where contracts for several thousand dollars' worth of supplies should have been awarded on a competitive basis and issued as one order, the total purchase was split up into a number of small orders, no one of which exceeded $1,000.

As evidence of the abuse of what was originally intended as an emergency provision, an analysis of the voucher records in the Department of Finance for a certain year showed that out of a total expenditure of $13,023,800 for supplies, $3,568,797 was expended through the medium of the open-market order. Furthermore, a comparison of the unit prices paid by the City of New York for supplies purchased upon publicly advertised contracts, with those purchased upon open-market orders, showed that these open-market orders cost approximately 25 per cent more than when the same supplies were purchased by competition. The City of New York, through its Comptroller, has recommended a scheme for meeting emergency requirements by what is known as the Bulletin Board Announcement, whereby such emergency requirements would be posted on bulletin boards and competition would be thus induced.

From the foregoing brief comparison of two radically different purchase systems, the defects of the

decentralized method are so apparent that the surprising thing about the whole situation is that anything but a central plan of purchasing could ever be seriously considered. The answer, in the case of the City of New York, is found in the fact that while this recommendation was made in 1913 by the City Comptroller, the Legislature of the State of New York has not, at the time of this writing, as yet authorized its enactment. While the status of purchasing standardization is far more advanced in the average manufacturing company than in municipal organizations such as the one here cited, the abuse of the open-market order or its equivalent is found in many cases. There is only one remedy, and that is the centralization of all purchases through the purchasing department, in whose executive will be reposed this responsibility. This same executive will be held accountable for every phase of purchasing incidental to the conduct of the business.

Distributing and Accounting For Materials.—Every well-planned purchasing organization should have for its object the concentration of purchases, increased competition, the establishment of adequate bases in the form of specifications, samples, and so on, and their uniform enforcement. This latter phase would, of course, be attended to by the inspection department of the factory working in co-operation with the purchasing department. It should furthermore have for its object the reduction of the time required to furnish all materials, supplies and equipment, and through the internal stores department of the factory, should see that sufficient stocks of materials and

supplies used by the manufacturing departments are carried; and that these stocks on hand at any time do not exceed the maximum stock limits or fall below the minimium requirements set for any class of goods that these manufacturing departments use.

It should have absolute control over the distribution of all materials and supplies to the various departments of the factory, through the use of comprehensive and uniform departmental and general storekeepers' records, accounts and perpetual stock inventories. It should exercise control over the purchases requested by the various units of the factory organization, by means of a constant comparison with the budget authorizations for these respective units. It should recommend to the general management of the factory such changes in these budget authorizations as, from its experience, it may find advisable from time to time. Through these records it should be able to show at any time the extent of the use of supplies and materials and the totals chargeable against each department using them. The most important function of any stores system is to control and account for the receipt and distribution of all materials and supplies for which it has been charged.

Authorizing Expenditures.—The method of authorizing expenditures for supplies and materials is simply to have a lump sum authorized by the management for expenditure during a certain period of time. After this authorization has once been made, it should then be so subdivided that each department or organization unit of the factory will know exactly how much it is allowed to spend during that time.

This information should then be issued to these respective organization units, and a copy should be retained by the purchasing department to be used as a check against the expenditures which it is asked to make during that period. When a purchase requisition is received by the purchasing department, it should first be compared with the stock on hand in either that department or any other department of the factory. If it is found that the demand cannot be met by an internal exchange, whereby a department having an excess of this material would receive credit for the transfer to the department requiring it, the extent of the purchase should then be carefully checked up and compared with the balance remaining at that time in the departmental budget. If it is found that the purchase will not exceed the permissible expenditure, the purchase can then be made. On the other hand, if it is found that the quantity will have to be reduced, the matter should be taken up by the puchasing department with the department requesting the purchase, to see whether the request cannot be held over until the next period—or, in order to have the quantity reduced. In the latter case, the purchasing department may often find it advisable to point out to the manufacturing department requesting the purchase, that it will cost the company money to make the purchase in small quantities. This will often help to bring forcibly to the attention of the various organization heads the importance of making their requisitions in bulk.

Purchase Requisitions.—As all things must have a beginning, so the purchasing department starts its

work with the receipt of these purchase requisitions. Form 42 shows a specimen purchase requisition, whereby provision is made for the checking up of all this information. Each purchase requisition should have the approval of the head of the department from which it has originated, or that of the general storekeeper if the goods are ordered to replenish the general-stores stock. Under the first column, "Quantity," the department head notes the quantity required, and in the sixth column, "Quantity or Weight," posts the unit of weight or measurement in which deliveries are to be made. Under the second column, headed "Requirements," a clear description of the materials

FORM 42

ORIGINAL REQUISITION

Budget Fund.______________________ Charge Account No.______

Purchasing Dep't.:- Date ______________

Gentlemen:-

The undersigned requests that you procure and forward to Store No. ________ the following articles.

QUANTITY	REQUIREMENTS	ON HAND OR ORDER	MONTHLY CON-SUMP-TION	FOR WHAT PURPOSE	QUAN. OR WEIGHT	APPROX. VALUE	ORDER NO.

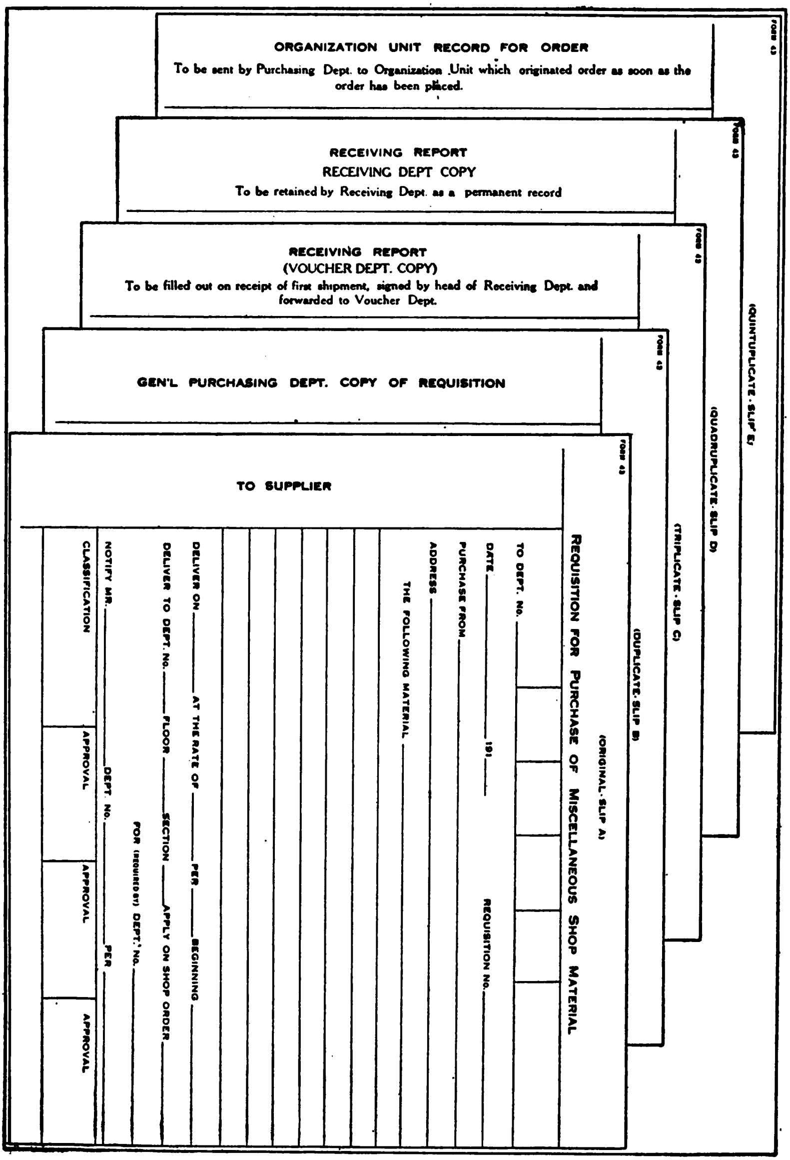
CERTIFICATION AS TO AVAILABLE FUNDS SIGNATURE OF DRAWEE

SIG.______________________ ______________________

FORM 42. PURCHASE REQUISITION

requisitioned should be given. Under the third column, headed "On Hand and Due," the purchasing department will have inserted by the stores department the material then on hand in its stock rooms or on order. In the fourth column, headed "Monthly Consumption," the quantity in units of weight or measurement are then posted by the stores department, based on the consumption of the preceding three months. In the column headed "For What Purpose" should be given a definite statement as to how the materials or supplies are to be used. In the column headed "Approximate Value," the general purchasing agent will have entered the approximate value of the materials on requisition, based upon the current market prices or, when these are not available, on the basis of the preceding orders for the same class of material.

Purchase Order.—When the purchasing agent receives a duly authorized requisition and finds that a purchase has to be made, an order is issued to the company offering the best prices. A specimen form of a purchase order is shown by Form 43, which is made up in quintuplicate. An examination of this form will show that it is so arranged that all five of these detachable slips can be written at one time on a typewriter by simply inserting carbon sheets. This purchase order shows the department requisitioning the material, the name and address of the supplying company, a description of the material, and the shipping instructions. It also provides for the classification of the order and the necessary approvals. The original (slip A) is sent to the supply-



FORM 43. PURCHASE ORDER IN QUINTUPLICATE

ing company, the duplicate (slip B) is retained by the purchasing department, the triplicate (slip C) is sent to the receiving department together with slip D, and the last (slip E) is sent by the purchasing department to the organization unit which originated the order.

When the material is received, the receiving department fills in on the back of Forms C and D the quantities received, and then forwards to the voucher department Form C, which is the receiving department's report, certifying that the material has been received. The receiving department retains slip D as its permanent record of material received. Upon receipt of slip C by the voucher department, payment can be made in the regular manner. When partial deliveries are to be made from time to time and when payments have to be made before the entire shipment has been received, the receiving department will supplement its original notification to the voucher department with additional slips, on which will be noted the quantities received.

The use of such a form as the one here described provides a check against any payments being made except on purchases originating from the purchasing department, and also provides for a permanent record for the receiving department and a record for the department that originated the requisition. This latter notification enables the department to check up its purchases and, since all purchase orders are numbered, it likewise provides a sequence for the voucher department in locating any items on which payments have not been made.

Purchase-Order Register.—When the purchasing department issues an order, it is posted in what is called an "Order Register," shown by Form 44, in which each different class of material is separately classified. This is best accomplished by carrying separate pages for each classification. Lumber for example, would be recorded under different classifications as to size, kind, and so on, while in the same way coal would be classified as to whether it were stove, pea, nut, soft, or some other kind. This classification is then also posted on the original purchase requisition. In no case would a page in the order register show items covering more than one specification.

Reference to this form will show that the first half of it contains the details as to the orders issued, while the second half makes provision for subsequent entries when deliveries are made on account. Space is provided for the invoice date and the price, total of invoice, and notations. When more than one shipment is made, the receipts of subsequent shipments are entered on the blank lines provided for that purpose. A record of this kind in the order register gives a complete history of the purchases, and includes all information necessary for the compilation of reports relating to purchases when such reports may be required by the management. In like manner, reports can be made from this record, of comparative consumption of various kinds of materials and supplies by the different departments of the factory, and these can very often be used by the management to suggest economies that might otherwise

FORM 44

CLASSIFICATION NO. ________

SHEET NO. ________

DATE OF ORDER	ORDER NO.	REQUISITION NO.	CHARGE ACCOUNT	FOR WHOM ORDERED	FROM WHOM ORDERED	MATERIAL ORDERED		AT PRICE ORDERED	RECEIVED ON ACCOUNT		INVOICE		TOTAL OF INVOICE	REMARKS
						QUAN.	DESCRIPTION		QUANTITY	WEIGHT OR MEASURE	DATE	PRICE		

FORM 44. PURCHASE ORDER REGISTER

escape its attention. These records can also be used to show the vendor's promptness in making deliveries, or his unreliability.

Voucher Register.—After the voucher department has entered the order for payment in a "Voucher Register" (Form 45), its copy of the original purchase order is then sent to the stores department, which posts the supplies received either on stock cards or stock ledgers as the case may be. This will be discussed more fully a little later on in the present chapter. The totals of all vouchers issued for payment each day by the voucher department are arrived at by totaling all the entries that have been made in the course of the day in the voucher register. A record of this total is then sent to both the general manager and the purchasing department, to show the extent to which supply appropriations authorized in the budget have been expended.

Voucher Department "Contract Register."—The purchasing department often finds it advisable to make purchases under a contract arrangement with the supplying company. These contracts may cover the supplies for a number of different departments, or for stock. Therefore, in order that the proportionate charge may be made against each department or unit of the factory organization requisitioning supplies, the total charge for any partial shipment of goods so ordered on contract should be so classified that the proportionate charge will be made against each department according to the ratio of the total material requisitioned by the department to the total under contract. This classification should be made

FORM 45

VOUCHER REGISTER

______________ 191__

VOUCHER	ORDER	VENDOR	RECEIVER	RAW MATERIAL	SHOP EXPENSE SUPPLIES	EQUIPMENT		TOTAL VOUCHER	FUND
						NEW	REPLACEM'TS		

FORM 45. VOUCHER REGISTER

directly on the invoice or on the copy of the original purchase order. When invoices for materials and supplies so ordered under contract are received by the voucher department, they should be entered in what is known as a "Contract Register" (Form 46), in which are entered the quantity and value of the supplies and materials received as partial shipments. A similar contract register is also kept by the purchasing department, in which the entries made will show the deliveries to the various departments as a lump sum. The records of the various departments using this material will provide the necessary details.

Centralized System Controls Orders.—One of the most important functions which can be performed by a centralized system of purchasing such as the one that has herein been outlined, is that of providing a prompt means of executive control over all orders which have been issued and over the payment of those orders. With authority to make all purchases delegated in the general purchasing agent of a company, it is easily possible to have daily statements prepared showing the complete approximate contingent liability for all material and equipment on order, and also the actual liability for invoices that have been vouchered for payment. A statement of this kind can be made as brief or as comprehensive as conditions may warrant, but the usual practice in manufacturing companies is to segregate the purchases according to equipment, raw materials, purchased piece parts, and supplies. A detailed statement of this kind, showing the approximate value of materials and supplies purchased, can also

FORM 46

CONTRACT NO. ____________

DATE OF CONTRACT ____________ CONTRACTOR ____________

DATE OF EXPIRATION ____________ TITLE OF CONTRACT ____________

CONTRACT REGISTER

ESTIMATED AMOUNT ____________

DATE OF NOTICE ____________

ITEM	DESCRIPTION	ESTIMATED QUAN	UNIT	PRICE	VOU.		VOU		VOU		VOU		VOU		VOU		TOTAL	
					QUAN	AMT	QUAN	AMT	QUAN	AMT	QUAN	AMT	QUAN	AMT	QUAN	AMT	QUANTITY	AMOUNT

FORM 46. CONTRACT REGISTER

be used by the stores department. It can be embodied in monthly or quarterly statements, showing the total charges for deliveries made to the various departments of the factory.

Daily Statement of Contingent Liability on Purchases.—Inspection of Form 47 will show that the first half of this form provides space for entering the total value of orders unvouchered up to the preceding day, and also the approximate value of orders issued during the current day. It also provides space for showing the value of orders vouchered during the current day, and the total of all orders unvouchered up to the day the statement is issued. The second half of this

BUDGET AUTHORIZATION & APPROPRIATION REPORT

	MATERIALS & SUPPLIES		PURCHASED PIECE PARTS		EQUIPMENT		TOTALS
					New Equipment	Replacements	
Approximate Value of orders unvouchered to end of previous day							
Issued this day							
Total							
Less those vouchered this day							
Total							
Approximate value of all orders issued during current month to end of preceding day							
Issued this day							
Total for month to date							

SIGNATURES ______________________ BOOKKEEPER ______________________ GEN'L PURCHASING AGENT

FORM 47. BUDGET AUTHORIZATION AND APPROPRIATION REPORT

form shows the approximate value of all purchase orders that have been issued in the course of the current month up to the preceding day, the approximate value of orders issued during the current day for which the report is made, and the grand total of all orders that have been issued during the month, up to the day on which the statement is issued. A supplementary memorandum should also be made showing the value of orders previously vouchered during the current month up to the preceding day, and the value of all orders vouchered during the day in which the statement is prepared. This memorandum will also show the total of all orders that have been vouchered during the current month, including the day in which the statement is issued.

Value of Daily Statements.—A daily statement of this kind showing the status of orders and vouchered payments, when issued along the lines here outlined, will give a comprehensive idea not only as to the status of material movements themselves, but also concerning the financial phase of the matter. It will show from day to day the approximate contingent liability of the company, all purchases which have been ordered but which have not been vouchered, and will set forth the actual liability for all supplies, materials, and so on, which have been ordered and already vouchered. From a management and purchasing department viewpoint it will reflect the extent to which the appropriations authorized in the monthly or quarterly budget of the company are being drawn on, and will provide a definite basis for arriving at the balances still remaining in the budget.

FORM 47

DETAILED DAILY STATEMENT

Approximate Value of Purchases ______________ 191____

ORDER NO.	REQ. NO.	FROM WHOM ORDERED	FOR WHOM ORDERED	MATERIAL	REMARKS	TOTAL OF VOUCHER	MATERIALS & SUPPLIES		PURCHASED PIECE PARTS		EQUIPMENT			
											NEW EQUIPMENT		REPLACEMENTS	
							AUTHORIZATION	APPROPRIATION	AUTHORIZATION	APPROPRIATION	AUTHORIZATION	APPROPRIATION	AUTHORIZATION	APPROPRIATION

FORM 48. DAILY STATEMENT OF PURCHASES

Controlling Daily Expenditures.—Aside from the direct information it furnishes on budget authorizations, such a report is of value to the management in controlling unwarranted daily expenditures at the beginning of any month or quarter for which the budget is issued. It is a well-known fact that when authorizations of this kind are made in a budget the departments of a factory immediately start to issue orders for supplies, even when they are often not immediately required. This is a human weakness which is very hard to control and, while these departments are acting in conformity with the general scheme in confining themselves to purchases not exceeding the budget provision, it nevertheless very often works hardship on units of the factory because of the fact that there is a tendency to use supplies in excess when they are available. The result is that some time before the end of the period is reached, emergency orders have to be authorized and put through to supply these departments with their actul requirements. Daily statements of this kind therefore offer a means of exercising executive control over this phase of the matter, and can undoubtedly be used to the mutual advantage of the factory as a whole and also its various departments.

Price Cards.—Since the mechanism of purchasing is dependent to a large extent on the accessibility of unit prices, therefore some method whereby these prices can be tabulated and made easily accessible is essential to economy in purchasing. This applies both to contract orders and what have been referred to as open-market orders. In order that effective con-

trol may be exercised over the expenditures for supplies, and so on, these prices should be kept up to date on what are known as "Price Cards." Each card contains information pertaining to only one item, and the cards are alphabetically arranged according to the various classes of supplies and merchandise that the company uses. Filing cabinets provide an easy means of reference—the style of card used is dependent more or less on the particular line of purchase engaged in.

Form 49 shows a price card arranged so as to provide information in regard to subsequent quotations from different firms. The average of these quotations, based on past experience, is posted on top of the card along side of the word "Price," and a full description of the article is also filled in at the top of the card. It should be understood, of course, that these prices are subject to adjustment to the ruling market prices for any particular class of supplies, but the information contained on the cards provides a means for arriving at the approximate value of goods

ARTICLE								PRICE CARD				PRICE			
NAME OF FIRM	DESCRIPTION OF ARTICLE	FILE NO													

FORM 49. PRICE CARD

purchased. The prices are used in the making of the entries on Form 42, under the head of "Approximate Value," and also in the preparation of the daily statement of expenditures.

The prices contained on these cards also provide a basis of comparison for the purchasing agent whereby he can determine whether the prices submitted by the different vendors are as low as might be expected. There is always the possibility that the lowest price submitted may be considerably higher than the proper market price for any particular line of purchased articles. Furthermore, there is always the possibility that, through laxity on the part of the general purchasing agent or his departments in securing bids, the orders may be given out without proper consideration. The remedy provided by one manufacturing company that I know, to meet just such a condition as this, was to require the purchasing agent to have at least six different bids submitted on each purchase, except when, because of the particular line of goods, competition could not be introduced.

Form 50 is a specimen of a form that can be used in asking for such bids. The use of a standard form of this kind provides uniformity in the filing of the purchasing department records. Form 51 can be used in conjunction with Form 50 for recording the unit prices submitted by the various bidders in response to the requests for prices sent out by the purchasing department.

Tracing Purchase Orders.—So many disastrous effects can result from undue delay in the fulfilment of

FORM 50

OFFICE OF PURCHASING DEPT.

BID NO. ________

DATE ________

Please quote your lowest price ON THIS SHEET for the following supplies delivered to SMITH-JONES COMPANY at ________
STATE BY WHAT DATE YOU CAN MAKE DELIVERY, AND TERMS OF PAYMENT.
No charge for Packing or Drayage or charge of any kind for any purpose will be allowed over and above prices quoted on this sheet. The right is reserved to accept or reject quotations on each item separately or as a whole.
This sheet must be signed below by bidder.
PLEASE RETURN THIS SHEET WHETHER YOU QUOTE OR NOT.
QUOTATIONS WILL BE RECEIVED UNTIL ________

ARTICLES REQUIRED	PRICE	VALUE	

SUBMITTED AS ABOVE

SIGN HERE ________

FORM 50. REQUEST FOR BIDS

FORM 51

ABSTRACT OF PROPOSALS TO FURNISH SUPPLIES

QUOTATION NO. ________
REQUISITION NO. ________
ORDER NO. ________
DATE OF ORDER ________
WITH WHOM ________
____
CLOSED ________

QUANTITY	DESCRIPTION	PRICE PER ____ DEL'D	PRICE PER ____ DEL'D	PRICE PER ____ DEL'D	PRICE PER ____ DEL'D	PRICE PER ____ DEL'D	PRICE PER ____ DEL'D

FORM 51. PROPOSALS TO FURNISH SUPPLIES

orders and the subsequent delay in the receipt of the material ordered, that no well-organized purchasing system is complete without some provision for tracing orders that have not been delivered in accordance with the dates specified on the order. A form provided for this purpose is Form 52, which is recom-

No.

Smith-Jones Mfg. Co., Inc.

OFFICE OF THE GENERAL PURCHASING AGENT.

....

....

....

Gentlemen:

We have not as yet received your invoices for supplies on our Order No........
Date............Item.................

If order has been filled please send us the invoices in quadruplicate by return mail; in case it has not, notify us when you will ship.

Yours truly,

....

Per..................

It is not necessary to write a letter. Please write your answer below and return notice.

FORM 52. TRACER FOR UNFILLED ORDERS

mended for use instead of the ordinary letter request. These forms are part of the permanent records of the purchasing department, and besides being used to expedite deliveries, can also be used in checking up the

reliability of the different firms with whom the company deals, as regards making deliveries as promised.

Registered Contracts.—The distinction between general and contract purchases has been discussed in a general way, but there is still another point to be considered in regard to the latter type. When goods are purchased on open-market orders by the purchasing department by what is known as the general method of purchasing, no security deposit, or bond is requested by the company. On the other hand, in the case of registered contracts, for which a security deposit or bond is required, a form similar to Form 11 can be used in connection with the establishment of the claims of the company when forfeiture of deposits or bonds is necessitated.

This treatment covers in a fairly complete manner the direct-purchasing phase of manufacturing. It has to do, however, only with those matters that pertain directly to the securing of the materials, supplies and equipment which the factory as a whole may require. It does not deal with the internal-storing and distribution phase, which is known as the "Stores System." After the material has been received and inspected, it is sent to the various storerooms located throughout the factory, from which it can be distributed to the departments requiring it. In no event should material be sent directly to departments; it should in all cases be issued through the store-rooms on duly authorized demand. Before this distribution phase can be considered, however, it is necessary to take up the question of the function of the stores department as a whole.

CHAPTER X

STORES ACCOUNTING

(Continued)

Shop Stores.—The shop stores organization is usually under the supervision of a general storekeeper, who is responsible for maintaining the proper amount of supplies and materials required by the manufacturing departments for carrying on their work. This therefore requires that he must requisition the purchasing department for supplies and materials that need replenishment from time to time, and in this connection he must also state whether there is a sufficient amount left in the budget authorization which can be appropriated for this purpose. The storekeeper is required to state the quantity of each article or class of merchandise on hand in the various storerooms, the quantity due on uncompleted deliveries of goods on order, and the average monthly consumption of each class of material purchased. These figures will be based upon the quantities issued for the preceding month or quarter, as the case may be. This procedure of course requires the maintenance of a perpetual inventory of all stock held in the storekeeper's department.

General Stores-Invoice Register.—Upon the receipt of materials or supplies on order by the stores department, the details of either the delivery sheets ac-

companying the delivery or of the delivery as shown on the invoice covering the shipment, are entered in what is known as an "Invoice Register." The postings are made under the names of the different supplying companies, and are used as a check against the entries made in the receiving register, where all the goods received by the stores department are segregated according to the various classifications as explained in preceding chapters. Totals of these entries are made either weekly, bi-monthly, or monthly, according to the volume of the material received during a specific period. This stores-invoice register, then, shows the extent to which the deliveries have been made on any order, and the amount still to be so delivered. It also provides a basis for ascertaining the value of the materials and supplies received by the stores department during any period. From this information the general storekeeper can assist the purchasing department by bringing to its attention delays in shipment of goods on order. Form 53 is a specimen of a loose-leaf stores-invoice payment register, which can be used for this purpose.

Stores-Invoice Payment Register.—After the invoice has been approved for payment, an entry should be made in what is called a "Stores-Invoice Payment Register," which will show the full amount of the invoice, with any deductions that may have to be made for goods returned. The purpose of this invoice payment register is to account for the disposition of each invoice received, and to show on what date the net amount shown on the invoice may be charged against the "Stores Fund." Form 54 is a

FORM 53

GENERAL STORES INVOICE REGISTER

DATE	INVOICE NUMBER	FOR WHOM ORDERED	ORDER NO.	FROM WHOM PURCHASED	QUAN.	UNIT	DESCRIPTION	PRICE	AMOUNT OF INVOICE	REMARKS

FORM 53. GENERAL STORES INVOICE REGISTER

FORM 54

STORES INVOICE PAYMENT REGISTER

RECORD OF INVOICES

INVOICE NO.	DATE REC'D	ORDER NO.	DATE OF INVOICE	VENDOR'S NAME	AMOUNT	DEDUCTIONS	DATE RETURNED	DR. TO STORES

FORM 54. STORES INVOICE PAYMENT REGISTER

specimen of a form that can be used in this connection.

Contract Order Delivery Slips.—Considerable confusion very often results when materials or supplies are purchased on a contract basis, in accordance with which deliveries are made from time to time and invoices are entered monthly covering the amount of all shipments made by the vendor during that time. Sometimes the vendor, in making these deliveries, will use a delivery book of his own, in which the receipt of the goods is acknowledged by the receiving department. In other cases, he may leave a delivery slip of some kind on which a description of the quantity and kind of goods delivered is shown. The lack of uniformity in the method pursued by the different vendors, and also in the style and size of delivery slip used, results usually in considerable confusion, not only in the receiving department, but in the stores department as well.

These goods are of course simply receipted for, subject to inspection, and cannot be entered in the stores department invoice and the receiving register before they have been duly inspected and passed upon by the inspection department. It is therefore good practice to adopt some standard form of delivery slip that can be used for such contract deliveries. These slips can be supplied to the vendor with the request that all partial deliveries be indicated on them when the deliveries are made. This method will tend to provide a uniform procedure and will facilitate the work of all departments concerned. Form 55 is appropriate for this purpose.

Stores Stock-Receiving Register.—After materials

FORM 55

DELIVERY ACKNOWLEDGEMENT SLIP

Received from ______________________ Contract No. __________

Address ______________________ Order No. __________

Date __________

This will acknowledge receipt of the following items, which have been received subject to inspection.

ITEM	QUANTITY	UNIT	MEMO	DESCRIPTION OF MATERIAL	UNIT PRICE	AMOUNT

FORM 55. CONTRACT ORDER DELIVERY SHEET

or supplies have been received by the stores department, the details shown either on the delivery slips referred to in the preceding paragraphs, or on the invoices covering these, are entered in a "Receiving Register," in which the entries are made according to the classifications of the materials or supplies and are carried as separate accounts. A separate page is usually provided for each classification of such supplies or materials as the case may be. This register shows the following data: The date of the stores department's requisition, a description of the goods on order, the purchasing department's order number, the disposition that will be made of the goods—that is—whether it will be carried as stock or be immediately issued to some department, the units of the supplies so received—that is—whether pounds, gallons, or some other measure will be the basis on which the billing will be made by the vendor, the dates of the delivery, the name of the vendor, the in-

voice number, the price per unit, and the total billing price of the delivery. When goods are purchased for delivery in a number of different shipments, sufficient space should be left after the first entry to take care of subsequent deliveries when they are received. Form 56 shows the method of using such a form as the one here outlined. These forms are of course incorporated in a loose-leaf binder; or, if desired, they can be used as separate cards and carried in the file provided for that purpose.

Stores-Contract Register.—When purchases are made under contract, and when deliveries are made from time to time and the total of these deliveries in any month is billed at the end of that period, it is necessary that the stores department know the progress being made in carrying out these contracts month by month, and also the quantity and value of such deliveries at any time. This record is kept in what is called the "Stores Contract Register," which is exactly the same as the Contract Register, Form 46, used by the purchasing Department. These entries, when made under the proper headings, show the quantity and value of the deliveries made, and this information can then be used by the voucher department in checking up the total of all invoices that have been vouchered for payment on any and all contracts.

Rejected-Merchandise Order.—While it is the duty of the inspection department to see that all goods purchased conform strictly to the specifications called for by the purchasing department, it often happens that while such material may conform externally, in

FORM 56

STORES RECEIVING REGISTER

PAGE NO.____

ARTICLE ____________________ CLASSIFICATION NO. ________

DATE OF REQUISITION	DESCRIPTION OF GOODS ORDERED	NO. OF ORDER	ORD'R'D DLV'D TO	GOODS RECEIVED	DATE	VENDOR	NO. OF INV'CE	PRICE	AMOUNT	

FORM 56. STORES STOCK-RECEIVING REGISTER

FORM 57
REJECTED MDSE. ORDER

__________ STORES

DATE __________ NO. ____

TO __________

DELIVER TO __________

QUANTITY	DESCRIPTION	PRICE

ORDER NO. ____ DATE __________

FILE NO. __________

REJECTED MDSE. ORDER

__________ STORES NO. ____

__________ 191 ____

TO __________

DELIVER TO __________

QUANTITY	DESCRIPTION	PRICE	REMARKS

ORDER NO. ____ DATE OF ORDER __________

FILE NO. __________

STOREKEEPER

FORM 57. REJECTED MERCHANDISE ORDER

so far as the inspection department may be able to determine, with the requirements of the specified order, defects of different kinds very often appear after the material has once been workd on. These defects may require that a part of the lot, or sometimes the entire lot, be rejected.

In such instances as this, when the local inspectors or foremen in the various departments advise the stores department of defects, the general stores-keeper must take the matter up with the purchasing department, which in turn will take it up with the vendor. After an arrangement is made for the return of the defective material, the stores-keeper makes out a "Rejected-Merchandise Order," similar to that shown by Form 57. This will be seen to be made out with a stub attached to the main part of the slip. The stub is a counterpart of the main slip, and is retained by the stores-keeper in order that he

may account for the absence of the stock from the stock bins. The main part of the ticket is then sent forward to the purchasing department to be retained there as a record of this rejected material.

Action of this kind on rejected material should, whenever possible, have the approval of the inspection department or of some person in authority, in order that replacement of this returned material may be taken care of, especially in instances in which delay may result in the completion of any order in process of manufacture through a hold-up of this kind. Under such circumstances the necessary steps can be taken to provide the emergency requirements.

Rejected-Merchandise Delivery Slip.—When rejected material of this kind has to be returned to the source of supply, a slip similar to Form 58, which is made out in triplicate, is used. One section of this

FORM 58

REJECTED MDSE. DELIVERY SLIP

NO. ______

NEW YORK, ______ 191 ______

RECEIVED FROM

______ STORES

FOR

IN GOOD ORDER THE FOLLOWING:

QUAN.	DESCRIPTION OF PACKAGES

SIGN HERE ______

REJECTED MDSE. DELIVERY SLIP

NO. ______

NEW YORK, ______ 191 ______

DELIVERED BY

______ STORES

TO

IN GOOD ORDER THE FOLLOWING:

QUAN.	DESCRIPTION OF PACKAGES

DUPLICATE - KEEP THIS

FORM 58. REJECTED MERCHANDISE DELIVERY SLIP

form is retained by the stores-keeper, while the other two carbons are sent forward to the shipping department. When the material is shipped, one of these slips is signed by the express company or the vendor's truckman, and the other is retained by him as his copy of the receipt. The section which is retained by the shipping department, and which has been signed by the vendor or express company, is then returned to the store-room from which the rejected goods were sent, and is used by the stores-keeper as a basis for making in the receiving register the necessary entry showing the return of such goods.

Rejected-Material Credit Slip.—After the stores-keeper has had definite notification that the material has been returned,—notification which he received in the form of the rejected-merchandise delivery slip mentioned in the preceding paragraph—the stores-keeper makes out what is called a "Rejected-Material Credit Slip," similar to that shown by Form 59, which is made out in triplicate. One part is retained by the stores-keeper as his record, and the other two are sent to the purchasing and the billing department, respectively, where entries are made on their records showing that a credit for the amount of the returned goods is due the company on that particular order.

General-Stores Fund.—Any central plan of stores-keeping can be carried out successfully in a manufacturing business only if all materials, supplies, and so on, which are purchased either directly for stock or for the use of certain specific departments, first pass through the stores department. This means,

FORM 59

REJECTED MATERIAL CREDIT SLIP Invoice No.______

Date______

To______ Stores, Dr,

On account of rejected supplies delivered on order______to______

Quan.	Unit	Description	Price	Charge Account	Amount	

FORM 59. REJECTED MATERIAL CREDIT SLIP

therefore, that instead of charges being made directly against the various departments of the factory for any goods that have been ordered by them, the charge is first made against the stores department, which is credited with this material when it is drawn out of the various store rooms on requisition by these departments.

From an accounting point of view, this is best accomplished by having the different departments transfer their budget authorizations to the stores department as a sort of payment in advance. Such procedure

enables the stores department not only to exercise control over the consumption of materials and supplies by the various departments, but also to limit the extent of these orders at any time. If it is seen that sufficient benefit will accrue to the company in the form of reduced prices when goods are ordered in large quantities on a contract basis, the demands of various departments for the same classes of supplies or materials can be grouped, and thus a reduction in price can be obtained. On the other hand, if by virtue of the fact that no benefit will accrue to the company by ordering in large quantities, the stores department can limit the extent of such supplies or materials on hand at any time. Only the smallest possible investment from an efficient operating standpoint need be carried.

Control of Excess Supply.—There is a tendency for foremen or other executives in charge of manufacturing departments to stock up to the fullest limits in order that they may experience no delay or inconvenience in carrying on their work. There is, however, a happy medium that can be worked out by the stores department so that, instead of a large investment being tied up in stock that may not be needed for six months, a supply sufficient for say a month's requirements in advance will always be carried. This is one of the most important points with regard to the creation of a general-stores fund, and the plan can be developed to such an extent that any manufacturing company that perfects it can save by it a considerable amount of money each year in the form of interest on the investment in surplus stock.

Stores Department's Responsibility.—This method of stores control must necessarily depend for its successful operation on the ability of the stores department to have sufficient stock available at any time to meet the requirements of all departments of the factory. The best way to do this is to keep on hand at least one month's supply, and have another month's supply on order. As these supplies are ordered each month for stock, they are paid for after delivery by vouchers drawn against the stores fund. As fast as these supplies are drawn from stock by the different departments, they constitute a charge against the budget authorizations of the department receiving the goods; at the same time they constitute a corresponding and offsetting credit to the stores fund. This does not mean that every time the stores department makes a delivery from its stock, a credit passes through the stores fund. These credits are made at the end of each month against the stores fund, and at the same time the total debits are made against the departmental budget authorizations. It will therefore be seen that the credits will balance against the debits to a large extent, leaving only one entry which will be a debit to the stores fund for stock still on hand, and a credit to the departments for their unappropriated portion of the budget authorization.

Function of Distribution Register.—Because stores departments have to carry, and have on order, at least two months' supply, and also because the budget authorizations may be made only monthly to the various departments, it is recommended that the

stores-fund budget authorization for any month be made sufficient to carry it over the necessary two or three months in excess of the departmental authorizations. This, therefore, makes it necessary that the stores department maintain a record showing the disposition of all supplies and materials issued from stock at any time, in order that the monthly or quarterly statements may be made showing the balance to the stores fund at such times. This record is kept by the general stores-keeper in what is called a "Distribution Register."

I have discussed thus far simply the features pertaining to the stock-keeping phase of the stores department. It is necessary to consider also the method of issuing supplies upon requisition to the various departments of the factory, and the accounting procedure incidental to keeping track of the stock on hand and controlling the distribution of such materials and supplies.

Departmental Requisitions.—In accordance with the plan which has been outlined, regarding the maintenance by the stores department of stock requirements for the various departments, it must necessarily follow that all requisitions made by any department for supplies or materials must be made through the departmental stores-keeper. These requisitions must be certified to and approved by the head of the department making the requisition, and should then be sent to the departmental stock-keeper. The requisitions should be numbered in cardinal sequence, and should indicate the department requisitioning the material. The units of weight or meas-

ORIGINAL	DUPLICATE
FORM 60	
SUPPLIES DELIVERED	FOREMAN'S COUPON SUPPLIES RECEIVED
FROM STORE NO ______	FROM STORE NO. ______
DESCRIPTION ______	DESCRIPTION ______
QUANTITY ______	QUANTITY ______
______ DEPT.	______ DEPT
FOREMAN ______	FOREMAN ______
DATE	DATE
DELIVERED BY / CHECKED BY	DELIVERED BY STOREKEEPER
ENTERED BY MATERIAL ORDER DEP'T. / ENTERED BY SHOP EXPENSE DEP'T.	
THIS COUPON MUST BE SENT TO THE MATERIAL ORDER DEPARTMENT WHEN SUPPLIES ARE DELIVERED.	THIS COUPON MUST BE SENT, WITH SUPPLIES TO THE DEPARTMENT SPECIFIED.

FORM 60. DEPARTMENTAL REQUISITION ON STORES

urement must be specifically stated, and a clear, commercial description of the materials must be given. Forms 60, 61, and 62 are specimen requisition forms for supplies, raw material, and piece parts which may be used by the departments in requisitioning material from the shop stores.

Stores Requisitions.—Form 63 is a specimen of the form used by the stores-keeper in requisitioning the purchase of material from the purchasing department. Under the first, second, and third column respectively, the quantity units and description are posted. Under the next column is posted the quan-

ORIGINAL	DUPLICATE
FORM 61	
	FOREMAN'S COUPON
RAW MATERIAL DELIVERED	RAW MATERIAL DELIVERED
FROM STORE NO.______	FROM STORE NO.______
KIND______	KIND______
SIZE______	SIZE______
QUANTITY______	QUANTITY______
ORDER NO.______	ORDER NO.______
______DEPT.	______DEPT.
FOREMAN______	FOREMAN______
DATE	DATE
DELIVERED BY / CHECKED BY	DELIVERED BY / CHECKED BY
ENTERED BY MATERIAL ORDER DEPT.	
THIS COUPON MUST BE SENT TO THE MATERIAL ORDER DEPARTMENT WHEN STOCK IS DELIVERED.	THIS COUPON MUST BE SENT WITH THE MATERIAL TO THE DEPARTMENT SPECIFIED

FORM 61. DEPARTMENTAL REQUISITION ON STORES

tity, in units of weight or measure, that the general-stores department owes to the departmental store-room. In the fifth column the amount actually on hand in the store room is shown, and in the sixth column the quantity due on order. The average monthly consumption for the preceding quarter is entered in the next column, and the purpose for which the material is to be used in the column immediately following. This form is made out in triplicate; the original and the duplicate are sent to the general stores-keeper, and the triplicate is retained by the departmental stores-keeper as his record.

ORIGINAL	DUPLICATE
FORM 62	
	FOREMAN'S COUPON
PIECE PARTS DELIVERED	PIECE PARTS DELIVERED
FROM STORE NO. ________	FROM STORE NO. ________
W. M. NO. ________	W. M. NO. ________
QUANTITY ________	QUANTITY ________
ORDER NO. ________	ORDER NO. ________
________ DEPT.	________ DEPT.
FOREMAN ________	FOREMAN ________
DATE ________	DATE ________
DELIVERED BY / CHECKED BY	DELIVERED BY / CHECKED BY
ENTERED BY ________	
MATERIAL ORDER DEPT.	
THIS COUPON MUST BE SENT TO THE MATERIAL ORDER DEPARTMENT WHEN STOCK IS DELIVERED.	THIS COUPON MUST BE RETURNED WITH THE MATERIAL TO THE DEPARTMENT SPECIFIED.

FORM 62. DEPARTMENTAL REQUISITION ON STORES

Upon receiving the original and duplicate requisitions, the general stores-keeper, after aproving them, forwards the original to the purchasing department and retains the duplicate copy in his files. This duplicate copy is used in posting to the perpetual-inventory cards, which will be discussed later. The departmental stores-keeper enters in the column headed "Deliveries" the amount of the deliveries that he makes to the department which has requisitioned this material.

Checking Need of Supplies.—Before approving any requisitions, the general stores-keeper must decide

FORM 63

STORES REQUISITION

REQ. NO.________

STORE ROOM NO.________ CHARGE ACCT. NO.________

TO________STOREKEEPER DATE________

PLEASE FORWARD TO________

AT________

________THE FOLLOWING:

QUAN.	UNIT	DESCRIPTION	OWE	ON HAND	DUE ON ORDER	MONTHLY CON-SUMPTION	FOR WHAT PURPOSE	DELIVERIES

I HEREBY CERTIFY THAT THERE ARE SUFFICENT FUNDS APPROPRIATED AND UNEXPENDED TO PAY THE ESTIMATED AMOUNT OF THIS REQUISITION.

____

____

I HEREBY CERTIFY THAT THE ARTICLES ABOVE SPECIFIED ARE NECESSARY FOR

____

____

FORM 63. STORES REQUISITION

whether the supplies called for are needed; or from any other information regarding the condition of the market, and so on, he may have at hand, he must decide whether some other material can be substituted, or whether the demand must be immediately met. He must also refer to the authorizations to see whether or not the purchase to be made exceeds the budget authorization. This necessitates estimating the value of the order. When the general stores-keeper receives notification that delivery of the material has been made, and that it has passed inspection, he enters on his copy of Form 63, in the column headed "Deliveries," the delivery receipt-number. This entry, together with the entry in the general stores-keeper's

distribution register, ties up each item with the records of the departmental storeroom that requisitions it.

Stores-Advice Slips.—Because of the fact that the stock which is carried by the various storerooms of a factory consists not only of supplies and materials used in the factory, but also very often of piece parts that may have been purchased outside for use in connection with assembling the finished product, it very often happens that orders for such piece parts or supplies as the case may be, are received by the company

FORM 64

STORES ADVICE SLIP

SLIP NO. ____________

STORE NO. ____________

REQ. OF ________ NO. ________ DATE ____________________ FILE NO. ________

SHIP BY ________________ TO ____________________________

CHARGE ACCOUNT ____________

QUAN.	DESCRIPTION	CLASS & ITEM NO.	UNIT	PRICE	AMOUNT	

PACKED BY ____________ PRICED BY ____________ PRICES VERIFIED ____________

SHIPPED BY ____________________

DATE ____________________

RECEIPT NO. ________ DATE ____________ ____________ INVOICE CLERK

SEE OTHER SIDE FOR SHIPPERS TALLY

FORM 64. STORES ADVICE SLIP

FORM 64-A

STORES ADVICE SLIP

SHIPPER'S TALLY

NO. OF PKGS.	DESCRIPTION	MARKS	WEIGHT
	BOXES		
	"		
	"		
	"		
	BARRELS		
	"		
	BALES		
	"		
	BUNDLES		
	"		
	PACKAGES		
	"		
	CARTONS		
	"		

SHIPPER

CARRIER'S RECEIPT NO.__________ DATE __________

BILLING CLERK

FORM 64-A. REVERSE OF STORES ADVICE SLIP

from its customers or agents from time to time. When such orders as these are received and forwarded to the general stores-keeper, he makes out what are called "Stores-Advice Slips," on which he notes the description and the quantity of the goods so ordered. These advice slips are sent to the stores-keepers scattered throughout the various departments of the factory, with the object of having them make note of the supply of such goods as they may have on hand at that time. This is often necessary because of the fact that insufficient amounts may be car-

ried in any one stock-room, and in this way the general-stores department can draw on as many different storerooms as may be necessary to fill the order.

Forms 64 and 64-a show specimens of the front and reverse sides of one of these stores-advice slips. It will be seen that these carry the store number, requisition number, date, method of delivery, and so on. These advice slips also serve the purpose of keeping the stores-keepers posted as to the general demand being made on different classes of material that they may be carrying in stock. This same method of procedure is also followed when transfers are made from one or more storerooms to others. In each case the corresponding debits and credits for such transfers are made.

Stores-Delivery Receipts.—When such transfers of goods are made either to outside points or to different parts of the factory itself, these charges are invoiced in the usual way by the general stores-keeper. The price of such deliveries is based on the unit costs of the material furnished. When transfers of this kind are made, a delivery slip accompanies the material and the departmental stores-keepers—or any other receiver of such supplies—acknowledge receipt thereof on these receipt forms. They are then forwarded to the general stores-keeper's department, where they are kept on file and used as supporting data in making up the monthly or quarterly statements showing the value and kind of all stock issued from the storerooms during that period.

These receipts should be numbered, and when packages are sent out of the factory the receipt numbers

should also be noted on the packages, in order that in case the goods are lost in transit these numbers may provide an easy means of identification for both the stores department and the transportation company or other carrier. Form 65 is a specimen of stores-delivery receipt which can be used in such instances. When used material, equipment, or scrap is turned in to the stores department for disposition, the columns provided on Form 65 for price and amount are not filled in. These goods are simply disposed of to the best advantage by the stores department, and the appraisal and corresponding credit to the department which has turned these goods in are left with the general stores-keeper. The latter's decision is final.

FORM 65

STORES DELIVERY SLIP

Store No.________ NO.________

________191__

I AM FORWARDING TO YOU THIS DAY BY________THE FOLLOWING:

QUAN.	UNIT	DESCRIPTION	REQ. NO.	FUND	CHARGE ACCT.	PRICE	AMOUNT

________ STORE KEEPER

RECEIVED THE ABOVE IN GOOD CONDITION EXCEPT AS NOTED________191__

TITLE________

ON RECEIPT OF SUPPLIES THIS SHEET MUST BE SIGNED AND RETURNED TO THE SHIPPER

FORM 65. STORES DELIVERY RECEIPT

Stores Department-Distribution Register.—It is the custom in most manufacturing companies to consign all materials and supplies, when received, to a general storeroom or store-house, from which they are issued as the general stores-keeper or the stores department may direct. In order, therefore, that this department may be able to show in its monthly or quarterly statements full details concerning the value of all deliveries that have been made to each department or storeroom, it is essential that some record be kept of the distribution of such supplies or materials issued from stock.

This is done in what is called a "Distribution Register," in which a separate page is used for each different class of material. The description, the classification number, and the unit quantities in which the materials are carried, are printed on the top of each sheet. The information necessary for making the entries in this distribution register is obtained from the signed delivery-receipt forms, which have just been discussed. No two articles of different specifications should be carried on the same sheet; and when the goods are ordered on specification, the specification number or a full detailed description should be entered on the top of each of these sheets, in order that no mistake may be made in entering the charges or credits as this material is received or issued.

This register is used in making up the monthly statements, and can also be used whenever disputes arise as to the correctness of the debits or credits made to the various departments by the general-

FORM 66

STORES DEP'T. DISTRIBUTION REGISTER

CLASSIFICATION NO. ________

UNIT ________

ARTICLE

DEPARTMENT	RECEIPT NO.	QUANTITY	CHGE. ACCT.	AMOUNT	TOTAL

FORM 66. DISTRIBUTION REGISTER FOR STORES DEPARTMENT

stores department. These entries, as has just been stated, are substantiated by the receipts bearing the signature of the department receiving the material in each case, and in this way all questions as to mistakes can be very easily checked back. The material should always be classified according to whether it is a charge against raw material, shop expense, or equipment. Form 66 is a specimen of a loose-leaf stores-distribution register which can be used for such work.

Stores-Tracing Memorandum.—It very often happens that through unavoidable circumstances, supplies that have been requisitioned are not received within a reasonable time. When this is the case, the general stores-keeper or his department should be immediately notified, in order that the necessary steps may be taken to expedite delivery. This is best ac-

FORM 67

STORES TRACING MEMORANDUM

Store Room No.______

REPORT OF SUPPLIES REQUISITIONED BUT NOT DELIVERED

____________191

REQUISITION			SUPPLIES WANTED		REMARKS
OF	NUMBER	DATE	QUAN.	DESCRIPTION	

FILL IN INFORMATION IN ALL CASES WHERE SUPPLIES ARE REQUISITIONED BUT NOT DELIVERED

____
STOREKEEPER

FORM 67. STORES TRACING MEMORANDUM

complished by using a tracing memorandum similar to that shown by Form 67, which is filled out and sent to the general stores-keeper. He takes the matter up with the necessary parties concerned—that is, either the purchasing department or the departmental stores-keepers, as the case may be. By this method, the general stores-keeper can keep posted not only on delinquencies on the part of the vendors of purchased materials, but also on the delinquencies of people in his own department. It also often happens that requisitions are lost in transit, and a tracing memorandum of this kind will serve to bring the matter forcibly to the attention of the general-stores department.

Periodic Stores Statement.—In order that the accounting department of the factory may be able to make the necessary charges against the various other departments for supplies or materials issued to them during any period, statements similar to Forms 68 and 69 should be prepared by the general-stores department at the end of any month or quarter, as the case may be, and sent to the accounting department for this purpose. These statements also serve as a report of the stewardship of the general stores-keeper for that period.

The value of all goods purchased and handled by the stores department is obtained from the receiving register and the invoice record of vouchers which have been passed for payment. The value of such supplies or materials which have been transferred from one department to another are also obtained from the same sources. The value of the stock that

FORM 68

NO. ______

GENERAL STORES
STATEMENT FOR THE QUARTER ENDING

____

	DR.	CR.
VOUCHERED SUPPLIES ON HAND LAST STATEMENT		
CONTRACT VOUCHERS DURING QUARTER		
OPEN MARKET VOUCHERS DURING QUARTER		
RECEIVED BY TRANSFER FROM DEPARTMENTS		
TOTAL DEBITS		
TRANSFERED TO DEPARTMENTS:		
Raw Materials		
Shop Expense Supplies		
Plant Equipment-New		
" " -Replacements		
CONDEMNED		
TOTAL CREDITS		
ON HAND-VOUCHERED		
ON HAND-NOT VOUCHERED		

____
GENERAL STOREKEEPER

____
GENERAL PURCHASING AGENT

FORM 68. GENERAL STORES STATEMENT

was on hand throughout the various storerooms at the beginning of the period is taken from the report of the preceding period. In this way, this original charge, plus the additions that have been made during the period, constitutes the debits against the Stores Fund. Evidently, then, the difference between

FORM 69

GENERAL STORES NO ______

STATEMENT FOR THE QUARTER ENDING

____

CHANGES IN DEPARTMENTAL ACCOUNTS DUE TO TRANSFER OF SUPPLIES

CHARGE ACCOUNT	DR.			CR.		
	RAW MATERIAL	SHOP EXPENSE	PLANT EQUIPMENT	RAW MATERIAL	SHOP EXPENSE	PLANT EQUIPMENT

______________________ GENERAL STOREKEEPER

______________________ DEPARTMENT

______________________ DEPARTMENT HEAD

FORM 69. GENERAL STORES STATEMENT

the charges that are so made and the credit for the stock on hand at the end of the period, is what the stores department must show distribution of. The value of the material on hand at the end of such periods, as well as the value of inter-department transfers, is obtained from the distribution register.

All supplies on hand in the general storeroom or store-house at the end of the period for which the report is made up, whether vouchered or unvouchered, are stated separately. There is bound to

be a discrepancy between the actual amount of material on hand and in the general store-house as reported by the stores department, and the vouchers that have been charged against the stores fund during that period. This is due to the fact that there is always a delay in the forwarding of all vouchers by the purchasing department. The discrepancy may be taken care of by getting from the voucher department a list of the vouchers that have been received but not as yet passed for payment.

Perpetual-Inventory Record Cards.—While in the preceding paragraphs the general phase of stores-department procedure has been discussed, and special emphasis has been laid on the factor of purchasing and storing of materials and supplies, it should be kept in mind that all economies which may result from efficient methods along these lines will be of little avail unless proper control over all stock received, issued, or carried is exercised. Such economies resulting from efficient buying and stocking will be more than offset by losses that will occur if the supply system is not well planned. The planning can be done, however, by what is known as the "Perpetual Inventory System," through which adequate control at all times can be maintained over all stock factors.

Physical Arrangement of Store Rooms.—To operate a perpetual inventory, it is necessary that certain consideration be given to the physical arrangement in the storerooms in which such material is carried. This can be done by lettering the different sections set apart for the carrying of supplies, and number-

ing the compartments such as bins, racks, drawers, and pigeon-holes. A system of this kind will provide for the storing of the different articles carried in each storeroom. The ideal arrangement is to have these racks of steel or iron, and to have all the shelving and drawers also of metal construction. While this is the method of storing used in most of the large manufacturing plants, the same results can be accomplished by cheaper construction in the form of wooden racks and compartments. The main thing to be kept in mind is the necessity of so denoting and indexing the contents of each compartment or drawer that no time will be lost in locating any material called for.

This can be accomplished by simply having attached to each drawer a card on which will be shown the contents at any time. A metal frame of sufficient dimensions to accommodate a card can be easily fastened to the outside of each box or rack, and this card can be removed if necessary when entries for materials received or issued are being made. It is not good practice, however, to remove these cards from the bins at any time, for the reason that they very often become mislaid and the record is lost. When the supplies or materials are first put in the bins, the quantity is entered on this card, and is added to from time to time as additional deliveries are received. When the supplies are drawn out on requisition from stock, the quantity is posted in like manner, and by subtracting the quantity of stock so issued from the amount previously on hand, one can easily find the net balance and then post it on the

FORM 70

PERPETUAL INVENTORY CARD

14	3	297
RACK	LOCKER	STOCK BOOK PG.

MAX. 500
MIN. 100

Brass Caps. — 21

CLASSIFICATION AND ITEM NUMBER

DATE	ON HAND	RECEIVED	ISSUED
10/15	255	200	300
10/16	155	—	100
10/17	455	300	—
10/19	200	—	255
10/20	200	—	—

FORM 70. PERPETUAL INVENTORY CARD

card. Form 70 is a specimen of a perpetual inventory card that has been filled out to illustrate this method of making entries for stock on hand, received, and issued.

A physical count should be made from time to time by the various stores-keepers in charge of the departmental stock-rooms, to see that the net quantities as

shown on these cards agree with the actual contents of the containers. It is also good policy to show the maximum and the minimum stock limit on these cards, in order that the attention of the general-stores department may be called by the local stores-keeper to low stock at any time. A check against the quantities shown can be made at all times by comparison with the receiving and distributing registers, which have been previously explained. A form similar to this is carried in the office of the general-stores department, and the entries are posted from the original vouchers for materials received, and from the requisitions for materials delivered.

The perpetual inventory is one of the most important functions of the stores department—without it a chaotic condition is almost unavoidable. It not only serves the purpose of controlling stock limits, but also exercises a moral influence over those responsible for the quantity of the various stocks on hand at any time. It is the accepted and general method of controlling stock in almost all manufacturing plants, and while the form of the perpetual-inventory card often varies, the principle remains practically indentical in all cases.

Stores-Keeper's "Stock Book".—If the factor of human frailty did not have to be taken into consideration, the perpetual inventory would constitute a positive check at all times against the stock on hand in the various storerooms of the factory. Since the human element to be considered in this case is the stores-keeper, and because of the fact that he is no more infallible than any other individual, experi-

ence has shown that it is absolutely necessary to keep a constant check by means of the monthly physical inventory referred to in the preceding paragraph. An actual count of this kind can be checked against the balances as shown on the perpetual inventory records, and the verified records can be transferred to the stores-keepers "Stock Book." This book contains a record of all the supplies and materials that are carried in each storeroom, and the exact location of all of them.

Keeping the Stock Book.—Form 71 is a specimen outline of such a stock book, which should be permanently bound. Binding eliminates any possibility of pages being extracted or inserted to meet current contingencies. Reference to this form will show that the page is arranged in various columns showing the classification number, description of the material carried, the number of the compartment, drawer or rack as the case may be, and the purpose for which the goods are used. It will be noticed that there is a series of columns for each month of the year, in which is shown the quantity received, on hand, and ordered. These quantities should be shown in units of weight or measure, and the total issues for the entire year should be posted in the columns provided for that purpose. The amounts on hand at the end of the year are shown in the columns under the heading "On Hand, January 1st, 19—," in which are given the number, quantity, price, amount, and total value of each article on hand at the time of the inventory at the close of the year.

A record of this kind should be kept by each de-

FORM 71

STORES KEEPER'S STOCK BOOK

SECTION ______________

WHEN PRACTICABLE, SECTIONS IN THE STOREHOUSE SHOULD BE REPRESENTED BY LETTERS OF THE ALPHABET, AND COMPARTMENTS AND PIGEON HOLES NUMBERED.

RECORD OF NEW AND OLD MATERIAL

CLASS NO	DESCRIPTION	COMPARTMENT NUMBER	PURPOSE FOR WHICH USED	TOTAL ISSUES YEAR	JANUARY				FEBRUARY				MARCH				APRIL				MAY		
					ON HAND	ORDERED	REC'D	ISSUED	ON HAND	ORDERED	REC'D	ISSUED	ON HAND	ORDERED	REC'D	ISSUED	ON HAND	ORDERED	REC'D	ISSUED	ON HAND	ORDERED	REC'D
	FORWARD																						

FORM 71. SPECIMEN PAGE OF STORES-KEEPER'S STOCK BOOK

partmental stores-keeper, and should be used as a basis not only for checking his actual count, but also for drawing requisitions for the replacement of stock that has been drawn down close to the minimum limits. In the case of over-stocking, this also serves the purpose of showing whether or not the amounts on hand at any time are in excess of the maximum limitations; any excess quantities in such cases can be returned by the local stores to the general storehouse.

Disposal of Overstock.—It may happen that through mistakes an overstock of certain classes of supplies or merchandise is carried. Provision should therefore be made for authorizing a general-stores department or general stores-keeper to dispose of such surplus supplies or materials, in order that the investment may not exceed the authorized limits. This surplus can usually be very readily determined by those in the general-stores department from the records sent to them at the end of each month by the local stores-keepers.

It is quite often the case that when small excesses of stock beyond the maximum limits are carried in the local storerooms, they are not given very much consideration by the departmental stock-keepers. When, however, all these excesses are assembled and summarized, they quite often assume considerable proportions; the importance of controlling even small excesses can therefore be readily comprehended.

Disposal of Scrap.—Another phase is the disposal of scrap, which, when collected, also assumes considerable proportions and can be disposed of to much bet-

ter advantage in bulk by the general-stores department than by any individual stores-keeper contributing his small portion of the whole. The stores-keeper's stock book provides a means of testing the efficiency of the stores-department management, as well as the efficiency of the individual or departmental stores-keepers, by a comparison of the actual inventory figures at the end of the year with the figures shown on the stock book.

Annual Stock Inventory.—An annual inventory should be taken of all stock on hand by an actual count. This inventory, however, should not be made by the stores department, but by special inventory clerks delegated for that purpose. This can be done by listing the actual contents of each rack or bin, and noting the bin number so that it can be easily checked back if large discrepancies are shown. Many companies make the mistake of having this inventory work done under the jurisdiction of the stores department, where the natural tendency is to protect their own interests by covering up any large discrepancies. It is therefore always good policy in the taking of inventories to have this work done by persons who are not directly connected with the stores organization.

Pricing Inventories.—To price inventoried materials the established values of the stock on hand at the end of the year are used. The prices at which the goods have been extended during the year by the stores-keepers have naturally been the average of the prices paid. A variation may therefore occur where considerable fluctuations have taken place in the market

prices of these materials or supplies. The prices that are used, however, in the taking of the actual inventory should always be the current market prices at that time, since they are used to represent a part of the assets of the company at the beginning of the next fiscal year. The values as shown on the stores-keeper's stock book should therefore be changed to agree with the actual inventory values whenever such discrepancies as these occur. Form 72 is a specimen of a form which can be used for taking such annual inventories.

Tool Stock-Rooms.—While in the preceding paragraphs consideration has been given mainly to the question of supplies and materials from a stores-keeping viewpoint, those items which are classified as tools must also be considered. To those not familiar with shop procedure, the question may arise as to the method of differentiating between tools which are carried by the stores department and which are classified as "stores" items, and such other items as may be classified as shop equipment. For example, when a new machine is received it does not pass through the stores department, but is sent directly to the department that orders it. On the other hand, certain tools used on this machine would pass through the stores department when purchased. The frame of a hack-saw, then, might be classified as equipment, while the saw itself, which is fastened to the frame, would be handled by the stores department and be part of their tool stock. Consequently, while it is almost impossible, without giving a long line of exceptions, to classify those items which would come with-

FORM 72

ANNUAL INVENTORY OF SUPPLIES AND MATERIALS

NO. ____
PAGE ____

ON HAND ______________ 19 __ AT ______________________ STORE NO. ____

AVE. MONTHLY CONSUMPTION	UNIT	QUANTITY	DESCRIPTION	PRICE	AMOUNT	TOTAL
			AMOUNT CARRIED FORWARD			

FORM 72. ANNUAL INVENTORY OF SUPPLIES AND MATERIAL

in the jurisdiction of the stores department and those which would not, the line of demarkation is not as difficult to establish as it might seem on first thought.

Tools Drawn from Stock.—Tools handled by the stores department require very often a somewhat different method of control than that used for material and supply items. For example, in a large number of manufacturing plants a brass-check system is used, whereby the workmen receive their tools only on surrendering a brass check with their number stamped on it. This check is then hung on a rack which indicates the number of the tool drawn out by the workman, and he is held responsible for that tool until it has again been restored to the tool stock-room. In still other cases, cards are used on which workmen have to acknowledge receipt of the tools.

Layout of Tool Rooms.—The physical arrangement is also generally somewhat different from that of the average stock-room, because of the fact that the value of the tools carried in these rooms usually amounts to a large investment, and protective means of preventing access to the rooms are employed. Quite often the tool room is arranged in the form of a cage with a small window through which the tools can be passed. Each night the window and doors are locked so that the contents of the room are well secured. The necessity of this will be readily understood when it is remembered that a small die used on punch-press work often costs from four to five hundred dollars. Since hundreds of such dies, jigs, and other tools could be easily carried in one of these tool stock-rooms, it is necessary to protect them adequately.

CHAPTER XI

THE DISTRIBUTION OF SHOP EXPENSE—

Its Effects on Costs

"Shop Expense" A Vital Problem.—While in the previous chapters mainly the questions of Productive Labor and Material have been discussed, there is yet to be considered from a cost viewpoint that element of every cost of production known as "Shop Expense." It will be remembered that in the early chapters of this book I called special attention to the fact that a cost is made up of three component elements, viz., Productive Labor, Raw Material, and Shop Expense. While in those chapters that followed, the various ramifications of labor and material were considered from a control and record standpoint, it should now be apparent that these elements of cost are more or less easily controllable, provided certain standard methods are followed for recording each and every transactions.

The control of productive labor and raw material is, however, a simple matter when compared with the analysis and control of shop expense, for the simple reason that this latter element of cost is by far the most important of all these different elements which enter into the cost of each article produced. This derives its importance not only from its magnitude when considered relatively to the other two component parts, but also from what we may term its elusive

quality. Labor and material are quantities that may be calculated with comparative ease and with close accuracy, but so to distribute and apportion correctly the shop expense that shall be borne by each job as it passes through the factory, continually requires the closest possible analysis and study of all the conditions that pertain thereto. It is therefore of paramount importance that this question of shop-expense analysis and assessment against jobs be considered first in its general aspect, and then from the viewpoint of the particular method most suitable to specific manufacturing conditions.

A Common Mistake.—In solving the problem of the distribution of shop expense, it is the common practice to take the total of this expense for the previous year and, determining what percentage this total bears to the productive labor for the same period of time, apply this percentage to each job on the basis of the productive labor that has been charged to it. This method of applying shop expense is of absolutely no value whatever, except possibly in extremely rare instances in which the class of manufacture consists of only one article of merchandise, and the output of the factory is virtually the same, month in and month out. Even in such cases, however, the distribution of expense on the basis of productive labor would not be correct if this productive labor consisted of a mixture of both day-work and piece-work labor.

In order that we may fully understand the point here referred to, let us take as an example the case of a factory employing 500 people in five different manufacturing departments, and let us also assume

that the class of merchandise manufactured is brass goods, of which there are several dozen different kinds of articles produced. The manufacturerer finds that according to his books for the previous year his productive labor has amounted, in round figures, to $500,000, and his manufacturing expense to one half that sum, or $250,000. Instinctively, therefore, he reasons that if he adds 50 cents to each dollar of productive labor on jobs passing through his factory during the following year, he will have a reasonably accurate idea of what it has cost him to turn out each job. Thereupon, he issues an order to his cost department to figure costs for the ensuing year according to that formula, and then sits back with a virtuous glow of self-satisfaction, confident that he has solved the whole problem of cost-finding of any one or all of his different kinds of output, and has established a perfectly sound basis for billing and estimating purposes, for establishing selling prices, and for outlining his general business policy.

A comprehensive knowledge of the merest fundamentals of cost finding, would conclusively prove to him that such a hypothesis as the one upon which he is proceeding is wrong, and that costs based thereon would be worse than useless for estimating or billing purposes. Yet, while this manufacturer would argue for a full day in defence of his method, he would not devote one hour to studying the subject from a scientific viewpoint.

Now, let us see how close he has come to the real costs of production. We shall assume the factory to be divided into five different departments, as follows:

Department	Number of Employees	Productive Labor
Foundry	75	$ 45,000
Lathe	75	90,000
Milling and Drilling	100	90,000
Punch Press	25	25,000
Assembly and Finishing	225	250,000
Total	500	$500,000

Allocation by Departments Necessary.—Now, keeping in mind the fact that this manufacturer has decided to add 50 cents for shop-expense assessment to each dollar of labor cost incurred in producing any article, in order that the total of $250,000 of shop expense may be spread over the output of his factory for the ensuing year, and further assuming that the activity of his shop will be the same as that of the preceding year, on which the above figure for this expense was based, let us analyze this shop expense according to its component parts. This analysis, we shall say for argumentative purposes, shows the shop expense as varying all the way from $30,000 to $75,000 for the respective departments, and the productive labor from $25,000 to $250,000. At the same time we find the ratio of expense to productive labor varying in a corresponding degree. When reduced to terms of percentage of productive labor, the fallacy of applying one general overhead of 50 per cent for all departments becomes evident. It will be seen from the following allocation:

Department	Shop Expense	Productive Labor	Percentage of Productive Labor
Foundry	$ 30,000	$ 45,000	67
Lathe	75,000	90,000	83
Milling and Drilling	45,000	90,000	50
Punch Press	50,000	25,000	200
Assembly and finishing	50,000	250,000	20
Total	$250,000	$500,000	50

A careful study of this analysis of shop expense by departments will show that a very marked discrepancy exists between the relation of this expense and the productive labor for different departments. In other words, we find these percentages varying all the way from 20 per cent to 200 per cent of the productive labor in different departments, and only in one case other than that of the aggregate figures, does this percentage equal the standardized 50 per cent that this manufacturer intends to use in all departments. In other words, it immediately becomes apparent that where such a method as this is adopted some departments of the factory will be unjustly bearing the expenses of other departments, and that consequently the cost of the goods manufactured in one case will show as less than the actual cost; while in others, where the additional expense of these other departments is being charged to them, the true costs will be considerably higher than they apparently are.

In order that the extent of this error of compiling shop expense on a percentage basis for the whole plant without making distinctions by departments may be more readily comprehended, the following table has been compiled.

Department	Productive Labor	Shop Expense (Actual)	Actual Shop Expense as a Percentage of Productive Labor	Theoretical Shop Expense of 50 Per Cent	Error in Costs Due to 50 Per Cent Expense Method
Foundry	$ 45,000	$ 30,000	67	$ 22,500	— 7,500
Lathe	90,000	75,000	83	45,000	—30,000
Milling and Drilling	90,000	45,000	50	45,000	....
Punch Press	25,000	50,000	200	12,500	—37,500
Assembly and Finish	250,000	50,000	20	125,000	+ 75,000
Total	$500,000	$250,000	50	$250,000	

This total shows that the actual shop expense for the punch-press department is 200 per cent of the productive labor. Therefore, an application of the general rate of 50 per cent decreed by the manufacturer for all departments would show the cost of production in the punch-press department to be $37,500 under the actual cost. Similarly, the application of this general rate to the assembly and finishing department would show a cost of $75,000 too high, because the actual cost of manufacture in this department is only 20 per cent of the productive labor, as compared with 50 per cent would have been added by the method adopted by this manufacturer.

Averaging Percentages.—This brings out a point which is well worth remembering: namely, that percentages, when based on differing units, cannot be

averaged. Many of the largest and most efficient manufacturing plants are being run by executives who, for some reason or other, do not seem to be able to differentiate between right and wrong methods of applying percentages. One of the first rules of mathematics teaches us that percentages cannot be averaged unless they are all applied on the same basis. When different figures are used—such as for productive labor and shop expense for the various departments as used in the foregoing table—these percentages have no relation whatever to each other, as the calculations consist of complete entities in themselves. A plus percentage of 50 in one case would not cancel a minus percentage of 50 in another instance, unless the figures used in each case were exactly the same. One half of a watermelon does not compare with one half of an orange—although they both represent 50 per cent of their respective units of measurement. Therefore, this law of percentages should be thoroughly comprehended in order that this common mistake may not be made in arriving at cost figures.

Notwithstanding this fact, however, the average manufacturerer, when brought face to face with just such a condition as the one which has been pointed out in the preceding paragraph, will say, "All that may be very true, but what difference does it make if the departmental expense charges are wrong, so long as they average out in the completed cost?" The man who makes this reply is perfectly honest in his belief that it solves the whole problem of expense-distribution, and that his position in the

matter is impregnable; but what such an answer really shows is that he who makes it is ignorant of the fundamental laws of mathematics. If he would only pause to reason a little in the abstract, he would readily perceive that 50 per cent of X cannot equal 50 per cent of Y except under the single condition that X equals Y.

Illustration of Common Error.—To show how errors of this sort are made every day, suppose we take a concrete illustration and assume that a certain order has just been completed after passing through all the departments of a factory, and that it is now ready to be figured. The time-tickets give a total of 210 hours spent on the job. For the sake of simplicity, we shall assume that there is a uniform wage rate of 20 cents per hour, and also that on analyzing these time-tickets by departments we find the work on this job to have been divided as follows:

Department	Time in Hours	Rate	Labor Cost
Foundry	10	$0.20	$ 2.00
Lathe	20	0.20	4.00
Milling and Drilling	30	0.20	6.00
Punch Press	50	0.20	10.00
Assembly and Finish	100	0.20	20.00
Total	210		$42.00

Now if we add to the labor charged against this job the standard shop expense rate of 50 per cent which the manufacturer decided was to be applied to

all jobs, irrespective of the department in which the work was done, and if we assume that the material cost was $5, then the cost of this job would be $68:

Productive Labor	$42.00
Shop Expense (50% of Labor)	21.00
Material	5.00
Total Cost	$68.00

We found, however, by an analysis of the shop expense, that each of the different departments through which this job passed had a different rate of expense as compared with the productive labor of that department. Now, if we take the actual percentage of this shop expense for each department, and compile the cost of this job by figuring this expense independently for each department, we shall discover that there is a considerable variation between the cost as figured on the uniform 50 per cent basis and that obtained by considering the work of each department by itself. Figured on this basis, the costs would then appear as follows:

Department	Productive Labor	Shop Expense	
Foundry	$ 2.00	67%	$ 1.35
Lathe	4.00	83%	3.40
Milling and Drilling	6.00	50%	3.00
Punch Press	10.00	200%	20.00
Assembly and Finish	20.00	20%	4.00
Total	$42.00		$31.75

The shop expense, therefore, which should have been applied against this job amounts to $1.75, instead of $21.00, making an error of $10.75; that is to say, the shop expense that had been applied was only about two-thirds of the actual figure. The correct cost would then show:

Productive Labor	$42.00
Shop Expense	31.75
Material	5.00
Total	$78.75

Wrong Cost-Compilation.—Now let us consider what might happen as the result of such an error in cost-compilation. Assuming that the manufactured product had a highly competitive selling field, and that the percentage of profit which the manufacturer added to his wrongly computed cost of $68.00 was limited to 10 per cent, then the actual billing price of $74.80 would, instead of netting him a profit of $6.80, actually net him a loss of $3.95. Or, taking another viewpoint, we shall assume that this article had a market price of $75, and that irrespective of the cost of manufacture this was the limit of price which the customers would pay. Then, while the manufacturer was fondly imagining that he was reaping a profit of $7, or something over 11 per cent on his investment, the hard cold fact of the situation would be that he was actually losing $3.75 on each of these articles which he sold.

To sum it up with a homely illustration, the manufacturer who does not apply himself to the accurate determination of the actual cost of the output of each

department of his factory is like unto the man "who didn't know it was loaded"; and the awakening in the first instance is likely to be as rude as in the second. The student of this subject of shop-expense distribution will, however, naturally ask here, "What if he does lose money on this article, so long as he is making enough profit on some of his other lines to more than make up for this loss?" Or he may ask, "What is the manufacturer to do if, in order to keep all of his lines intact, he is forced to make some article on which he is losing money?"

Knowing the Exact Status of Manufacturing.—The whole point of this discussion, however, is not that of the selling policy of the manufacturer, but rather the importance of his knowing positively the exact status of the manufacturing phase of his business. If he chooses to sell his goods below his actual cost of production when he positively knows that such is the case, this then becomes simply a question of business policy. But on the other hand, if, as in the illustration just used, a manufacturer sells a product that is costing him more to produce than he is actually getting for it in the open market, an entirely different aspect of the case is presented. In this latter instance faulty management, and not business policy is indicated; and it stands to reason that any business run on such a basis cannot maintain its position in the manufacturing field for a very long time.

A farmer who raises chickens in order to sell eggs in the open market as a means of livelihood, and who does not keep a careful watch over his particular stock in trade will not usually find out until quite

late in the day that some thieving night prowler is not only killing his chickens but destroying the eggs as well. Just so long as the cause of the trouble was not definitely known he would not concern himself with this matter, but after the theft has once been discovered, he will take every means to protect his stock in trade. This case is analogous to that of the manufacturer whose business we have been considering. So long as he is not definitely aware of the losses that are occurring, he will be to a certain extent satisfied and will not investigate; but once let it get into his head that it is actually costing him more to make than he can sell for, and he will very quickly "get busy."

When to Investigate.—As to the second question, if a manufacturer is forced to sell an article at a price less than his actual manufacturing cost, it usually means that some other manufacturer is turning out this article at a much lower cost. This means that an investigation must be started, leaks must be located, and remedies applied through close supervision, until the cause of the trouble has been removed. Frequently it may be found advantageous to discontinue a certain line, but the fact that stands out above all others in relative importance is that it is essential to find out where the remedy lies. The application of the remedy is then a simple matter.

The Time Factor.—At this point it is worth while to consider still another phase of this matter. If a manufacturer is unknowingly losing money on some lines, and yet is able to show a substantial profit at the close of each year's business, this very fact is

prima facie evidence that he is making an abnormal profit on some of his other lines. By substantially reducing his selling prices on the lines showing abnormal profits, he may very well be able to monopolize all the business in that line, his increase in sales more than making up for the smaller profit per unit sold.

Shop costs—when compiled on the hit-or-miss principle of using one general rate for shop expense applicable to all departments and classes of work—will therefore be seen to be of very little value except in rare instances when the output is of the "mass production" style on a single type of merchandise. Shop expense may justly be termed a function of time, because of the fact that it increases in a ratio which is practically proportional to time. Administration, rent, depreciation, taxes, power, idle-labor expense, and so on, with the possible exception of that part of shop expense known as material expense, are all proportional to the time consumed in producing any article. In using the productive labor, therefore, as a basis of expense-distribution, it must be thoroughly understood that when such labor is used it is simply in lieu of, or as a function of, time; and only when it is so used is it permissible to use it as a basis of expense-distribution.

Factor of Piece-Work Labor.—A mistake is often made—not only by manufacturers, but also by cost accountants—of using productive labor as a basis for expense distribution, when a portion of this labor is piece-work. Even when the expense has been segregated by departments, the introduction of piece-work

labor will change the entire aspect of the case. This is due to the fact that piece-work is not a function of time, but of quantity. Hence as shop expense when not split up into its two main divisions—machine expense and material expense—and applied as two separate items to the shop cost, cannot be distributed correctly on any basis but that of time or functions of time, it will be seen that piece-work labor cannot be used as a basis of expense-distribution. This is because in no sense is it a function of time. Even when the material expense is added to shop costs as a separate item, it is not permissible to use piece-work labor as a basis for distributing expense.

It is not my intention to go into the question of machine expense or material expense in detail at this point, since these subjects will be taken up thoroughly in a later chapter. It might be well, however, for the student of this question to keep this point in mind—that the main divisions of shop expense are machine expense and material expense respectively, as this will help him to understand more thoroughly the reasons why certain of the further subdivisions of shop expense are treated in different ways.

Piece-Work Problem Illustrated.—It will illustrate more fully the error of using piece-work labor as a basis of expense-distribution to take as an example a department in which a certain expense rate has been figured on the basis of straight day-work labor. At a punch-press machine in this department, a man is being paid at the rate of 30 cents an hour. A time-study showed that the production of this operator

consisted of 3000 punched parts an hour, and therefore an arbitrary rate of one cent a hundred was set for all work of this kind turned out by him, this being equivalent to the operator's rate of 30 cents, when he is on a straight hourly wage basis. If we assume that the proportionate departmental rate of 60 per cent of the productive labor represents with fair accuracy the expense of operating this punch press, we will then have a charge of 18 cents (60 per cent of 30 cents) to cover the shop expense of this machine for each hour it is operated.

At this point piece-work is introduced, and the press man, seeing a prospect of higher wages, speeds up his production to such an extent that instead of 3000 pieces an hour, he now turns out 4000. At the rate of one cent a hundred, his pay now amounts to 40 cents an hour, instead of 30 cents which he earned on an hourly basis. When the clerk who figures this job applies his 60 per cent to the 40-cent piece-work labor charge, he loads an expense equivalent to 24 cents against this job, whereas if the workman had turned out his 4000 pieces an hour when on a straight day-work rate basis of 30 cents an hour, the clerk would have added only 18 cents instead of 24 cents under the piece-work arrangement. This makes a difference of 6 cents in the amount of expense charged against this job, or in percentage a difference of 33 1/3 per cent, as compared with the original method of determining this expense.

The only way to check up the comparative correctness of these two methods is to ascertain whether or not these charges for expense did actually increase

60 per cent on an increased production due to the piece-work method of wage payment. It is certain that administration, rent, light, depreciation, insurance, taxes and tool charges have remained practically the same, irrespective of the quantity of material produced by the operator in a given period of time. The small increase in power consumed, and the small additional expense incidental to the handling of the extra material turned out by the piece-work operator, are negligible quantities from an expense total. In other words, we find that from an expense viewpoint the total amount incurred is almost entirely dependent on the period of time consumed, and not on the quantity of the product produced. Therefore, the use of piece-work labor as a basis of shop-expense distribution is faulty in the extreme.

Relation of Labor to Time.—An accurate determination of the shop expense on the above job can be made only when the actual time required to stamp out the 4000 pieces is known by the cost clerk. In other words, the labor must be reduced to functions of time, or else be figured directly on a basis of time. When the cost clerk finds that the 4000 pieces have been stamped in one hour's time, he should apply his standard rate of expense for that department, which is 60 per cent of the productive labor, to the 30-cent labor charge that would have been incurred if the men had been on a straight day-work basis. In this way he can determine the proportionate charge against this job for expense, which in this case has been found to be 18 cents.

The illustrations that I have used are intended to

show the error, which many manufacturers make, of discontinuing time-keeping on jobs after piece-work rates have once been established. An appreciation of the importance of timing all jobs will be emphasized by constantly bearing in mind the fact that the unit of time must be used in all cases as a basis for shop-expense distribution. In some of the largest manufacturing establishments, the piece-work labor amounts to over 90 per cent of the total productive labor charged, and in most of these plants it will be found that the exact time applied on each operation is known, even to a small fraction of an hour.

Summary.—The purpose of this chapter has been to impress on the mind of the reader the vital importance of segregating all expense incidental to manufacturing, not only by departments, but also by smaller divisions when this is possible. The purpose has furthermore been to establish the unit of time as a basis for such distribution, and to point out some of the mistakes that are commonly made when a comprehensive knowledge of this subject is lacking. From an economic viewpoint, there is no factor pertaining to manufacturing which is of greater importance.

As the various ramifications of this question of shop-expense analysis and distribution to production centers will be taken up in chapters which follow, the main point to be kept in mind here is that this expense in any manufacturing company cannot be successfully applied as a part of individual costs of production unless the most careful and minute study is made. While in this chapter only the question of analysis by departments has been considered, further

analysis is possible by process points and also by individual machines. It is a mistake, however, to attempt to carry the assessment of expense to these machines by means of what is known as the "Machine Unit System" before the allocation by departments has first been proved to be practically correct.

Many accountants think that they can omit this primary stage and delve right into a segregation of expense by machines without first proving its distribution by departments. It should be apparent to any one with common sense that such methods of procedure are inevitably slated for failure, and this is one of the main reasons why so many plants that have attempted a segregation of expense according to machines have reached the idea that this method is faulty in certain respects.—You cannot start a building at the roof and build down.—A correct basis must first be established to a satisfactory degree of certainty, and then each successive step becomes simply a matter of careful analysis. The first steps, however, constitute the foundation ground work on which the entire scheme of expense-distribution is based and the strength of this underpinning must first be proved to have a safety factor.

CHAPTER XII

ESTABLISHING A BASIS FOR DISTRIBUTING MACHINE AND MATERIAL EXPENSE

Time in Expense-Distribution.—Except in cases in which the cost and the volume of productive labor and and raw materials remain practically the same year in and year out, and the shop expense bears a constant relation to each of these cost elements, this shop expense cannot be correctly assessed against individual jobs on the basis of either the labor, the material, or both. We have seen in the preceding chapter that the labor can only be used as a basis of expense-distribution, where it is indicative of time. In the same way, a combination of labor and material as a basis tends only to make the error greater than ever. And yet, a large number of manufacturing plants in this country today are assessing shop expense against jobs on the basis of the total for labor and material charged thereto.

Main Divisions of Shop Expense.—The importance of using the element of time as a basis of expense-distribution becomes, therefore, more and more apparent. However, while the general and approximate assessment of shop expense can be more or less safely made on the basis of time charged against any order, a further study and analysis of this shop expense will show that it can be segregated into two main divi-

sions, namely, Machine expense and material expense respectively. Perhaps the easiest way to define these would be to say that all shop expense other than that incurred in connection with the purchasing, receiving, handling, storing, and recording of material, is Machine Expense; and vice versa, all expense so incurred, is Material Expense.

Why Separate Material Expense?—The main reason for separating the material expense is that it is not incurred proportionately to time. For example, the cost of material on one job may be $50 and on another only $1, yet the total time involved in manufacturing might be the same in each case. On the other hand, the first instance might represent $50 worth of platinum and the second, $1 worth of brass castings. The expense involved in the handling and storing of the brass castings would, however, undoubtedly be considerably in excess of a similar expense incurred for the platinum. It is therefore evident that neither a time nor a material cost would be a safe basis on which to assess against individual jobs the proper charge for material expense.

Now, let us look into the reason for this still further. The expense involved in the transporting, unloading, storing, and moving of twenty-five bales of cotton would be far more than that for the same value in diamonds. Several thousand dollars' worth of gold could be easily carried by a man from the first to the third floor of a building, but an equal value of newspaper would require the use of a freight elevator to convey it to the third floor. What is the reason? It will be seen that the additional expense

was incurred because of the bulk of the paper and cotton in one case over that of the platinum, gold, and diamonds in the other. Therefore, the bulk of material used must become the basis of material-expense assessment against jobs, and not the elapsed time as in the distribution of machine expense.

From the few foregoing simple illustrations, the importance of segregating shop expense wherever it is possible to do so, should be readily apparent. While I have drawn just a general line of cleavage between these two main divisions of shop expense at this point, it will be seen that even further subdivisions of either machine or material expense, or both, can probably also be made. This would tend to make the loading of the shop expense against jobs more and more equitable than it so happens when only one general basis—such as that of time—is used.

A Weight Basis.—While the primary object of segregating shop expense into its component parts, from a cost accounting point of view, is that of accurate cost-determination, the fact should not be lost sight of that the more detailed an analysis of this expense can be made, the greater will become the possibility of maximum executive control over every phase of production. Hence, such a segregation of expense as is therefore carried on along the lines herein explained, performs a twofold purpose and consequently makes necessary a verification of all expense data before it is used for either of these purposes.

Therefore, in considering again this question of material expense, it will be well to note that while this expense is theoretically distributable on the basis of

bulk, for all practical purposes a weight basis can be used instead. This is allowable for the reason that in any particular class of manufacturing the kind of material handled would be more or less the same, month in and month out, and hence a distribution of material expense on the basis of the weight of the material used on any order, would be about correct.

Machine Expense.—While I have discussed the question of the material-expense division of shop expense, this represents the least important phase of it. All charges for expense, other than those pertaining to material, are called Machine Expense, and the analysis and distribution of this expense to centers of production involve what is by far the most important and difficult problem of cost-determination. In plants where the analysis of the shop expense is made only in order to establish one general rate of expense-loading for material expense, and another for machine expense, and where the management either through ignorance of the importance of extensive expense segregation or for other unaccountable reasons, do not apply this expense to jobs except as one general overhead rate, a further analysis of machine expense does not accomplish much. In a modern well-managed factory, however, this machine expense is not only further analyzed and segregated into its various subdivisions, but these subdivisions are in turn charged to productive work according to different bases.

Administration and Clerical Expense.—This, then, brings up the question as to what constitutes machine expense, and why it is necessary to treat the various parts thereof from different viewpoints. Considering

these parts in a general way in their usual order of treatment, we find that the first of these to be considered is Administration Expense.

This expense, we find on analysis, is divided into General and Departmental Administration Expense. All the expense chargeable to the first of these divisions must be charged in turn to the various departments of the factory. It includes not only the direct salaries for general superintendence, but also all other expenses such as stationery, rent, and so on, incurred by the general administrative body of the factory.

Departmental Expense, or Local Administration Expense as it is often called, includes all similar charges incurred in administration in any and all departments of the factory. This usually covers the salaries of foremen and service charges for rent, and so on.

Basis of Distribution of Administration Expense.—Administration Expense, whether general or local, is distributable on the basis of the number of employees. If, then, we assumed a case in which each department of a factory had the same number of employees, the general administrative charge would be the same for each department. The local or departmental administration expense might, however, vary and be different in each case, so that the total, per operative, for the combined administration expense, would be different for each department, even if the number of operatives were the same in each. An executive does not supervise floor space, or power, but he does supervise the men who occupy or govern these shop contributaries. Hence the reason for assessing administration expense on the basis of the number of employees.

In order, therefore, that this administration expense may be either generalized or departmentalized, it must first be segregated, by a classification of the charges as they are incurred, to either of these two divisions. The rest then becomes simply a matter of summarizing and pro-rating the totals of each division to the respective departments on the basis of the number of employees. While it is apparent that this matter of the distribution of administration expense involves nothing radically complex, it is also clear that it does necessitate a knowledge of the correct basis of distribution. This basis differs from that of other subdivisions of machine expense, as we shall shortly see. It is not my intention to elaborate at length in this chapter on the methods of analyzing the different kinds of expense and of distributing and assessing them to production centers, since these will be discussed more fully in later chapters. It will be well to note, however, at this time the unit bases used for distributing the different kinds of shop expense. They are as follows:

Expense.	Basis of Distribution.
Administration	Number of Employees
Power	Kilowatt Hours Consumed
Rent	Sq. Feet of Floor Space Occupied
Tool	Departmental Incurrence
Fixed Charges:	
Depreciation	Face Values of Equipment
Insurance	Face Values of Equipment
Taxes	Face Values of Equipment
Idle Labor	Departmental Incurrence
Material	Bulk or Weight of Material

Service Charges.—A careful consideration of these different bases of expense-distribution should raise certain important questions in the mind of the reader. For example, it is seen that Rent Expense is distributable on the basis of the number of square feet of floor space occupied. At the same time, however, we know that a certain part of this total floor space is occupied by material, or used for purposes incidental thereto. Consequently, not all of the direct expense chargeable as rent can be called machine expense, but part must be transferred to material expense. In the same way, not all of the power expense is machine expense, since a large part is undoubtedly used in connection with material. This is exemplified in the case of power used for operating freight elevators, heating dry kilns, operating mechanical conveyors, and so forth. A portion of administration expense must also be charged to material expense on the basis of the number of employees engaged in storing, handling, inspecting, counting, and so on.

Service Charge Transfers.—It will therefore be seen that while it is possible to classify a charge for, say, rent directly to Rent Expense as a subdivision of machine expense, this does not mean that the entire charge will remain a part of the division of expense against which it is classified. We have seen that a part of the direct charge for rent must be transferred to Material Expense because of the source of incurrence of parts of this charge. This, therefore, necessitates a transfer from Machine Expense (Rent) to Material Expense, and this transfer is called a Service Charge. In other words, we find that these Ser-

vice Charge Transfers are necessary because it is not possible to divide charges for expense items directly, against either one or the other or both of the two main divisions of Shop Expense.

For example, a bill for electric current used for lighting may be received from the supplying company at a certain time. The clerk who would do the classifying would not know, however, how much of this bill he should charge to Machine Expense and how much to Material Expense. Therefore he would simply classify it directly against Rent Expense—of which "light" is a part—and then later this charge, together with all other charges making up the total for Rent Expense, would be assessed against either Machine or Material Expense on the basis of the floor space areas occupied by machines and materials respectively.

Sub-Classification.—Realizing, therefore, the importance of correct initial classification of all charges pertaining to shop expense, let us assume that the Shop Expense Account is Account Number 20, and that we have set aside the following blocks of numbers to cover further sub-classifications along the lines explained:

Expense.	Account Number.
Administration and Clerical	20—001 to 099
Power	20—100 to 199
Rent	20—200 to 299
Tool	20—300 to 399
Fixed Charges	20—400 to 499
Idle Labor	20—500 to 599
Material	20—600 to 699

These blocks will therefore be indicative, when used for classification purposes, of the kind of expense incurred. For example, any charge classified from 20-001 to 20-099 would show Administration Expense, while in the same way, a bill classified 20-402 would indicate a Tool Expense charge. The specific nature of the charge would be found by referring to the list of classifications to see what 402 comprised, and which might be Repairs to Tools. In other words, this blocking system provides a means of building up a flexible classification system, and at the same time it establishes a distinct line of cleavage between different kinds of expense.

Sub-Classifying Administration and Clerical Expense.—The following is an example of how the block of numbers from 1 to 99 assigned to Administration and Clerical Expense are utilized in practice:

20-001—	Salaries:	Shop Supt. and Asst.
-002—	"	Cost Department
-003—	"	Payroll Department
-004—	"	Stenographic Department
-005—	"	Foremen's Clerks Department
-006—	"	Foremen
-007—	"	Asst. Foremen
-008—	"	Telephone Switchboard Operators
-009—	"	Depreciation on Equipment Used
-010—	"	Insurance on Equipment Used
-011—	"	Taxes
-012—	"	Telephone Rentals and Calls
-013—	"	Traveling Expenses
-014—	"	Telegrams
-015—	"	Stationery
-016—	"	Sundry

Any other administrative or clerical charges that may have been omitted when such a classification reference list is first drawn up, can then be added from time to time without in any way disarranging those already assigned and in use. Considerable importance has been given to this question of classification because when classification is poorly done and carelessly used, it can very quickly disrupt the most carefully planned cost system and be the cause of much dissatisfaction. It therefore behooves those who do not fully comprehend its application to study it most thoroughly in detail.

Consequently, in order that the practical application of these various principles may be more easily followed, actual figures will hereafter be used in the treatment of this subject of shop expense. To that end, let us consider the various classes of Shop Expense as being charged during the year with the following totals:

Summary of Shop Expense.	
Administration	$49,419.90
Power	22,632.30
Rent	54,363.20
Tool	156,402.05
Depreciation	87,943.18
Insurance	359.31
Taxes	1,054.74
Idle Labor	16,487.54
Material	35,128.07
Unclassified	1,209.71
Total Shop Expense	**$425,000.00**

It will be seen from reference to the above-mentioned total charges that Administrative Expense is charged with the sum of $49,419.90. This total has been derived from a summary of the various items classified against, and charged to, this expense during the year. The following detailed analysis of Administrative Expense shows how this total is made up.

Shop-Administration and Clerical Expense.	
Salaries:	
Shop Superintendent and Assistants......	$6,708.33
" Cost Department..................	3,864.15
" Payroll Department................	2,009.00
" Stenographic Department..........	2,234.15
Foremen's Clerks.......................	2,679.70
Special Studies..........................	3,347.50
Telephone Switchboard Operator..........	392.00
Foremen	15,696.55
Assistant Foremen......................	11,100.90
Depreciation on Shop Fixtures (Administration only)............................	294.79
Insurance on Shop Fixtures................	0.82
Taxes on Shop Fixtures....................	2.41
Telephones, Rental, and Calls..............	240.00
Telegrams	0.97
Traveling Expense (For Shop Only)........	6.80
Stationery	841.83
Total Direct Administration Expense......	$49,419.90

While the total of the direct charges made to Administrative Expense during the course of the year amounted to $49,419.90, this does not comprise the entire administrative expense, for the reason that no service charges have as yet been added. The prime

service charge which has to be made against this expense is for rent—that is, for the amount of floor space occupied by the administrative departments of the shop. If we were to take rent expense at this point and pro-rate it amongst the different divisions of Shop Expense, we should find that a certain portion of this rent expense would naturally be chargeable against these administrative departments on the basis of the proportion of floor space used by them. This rent expense will be treated more fully a little later, but in order that the discussion of administration expense may be more or less complete at this point, let us assume that this service charge for rent is $2,424.32. The grand total for Administration and Clerical Expense, then, amounts to $51,844.22.

Keeping in mind, now, the fact that the basis of administrative-expense distribution is the number of employees, we must next distribute this entire administration expense to the other divisions of Shop Expense on the basis of the number of employees coming under each of these divisions. These we will assume to be as follows:

Employees:	
In Manufacturing Departments	2,036
In Material Department	28
In Power Plant	4
On other than Shop Work	4
Total Employees	2,072

This amounts to approximately 25.03 per employee, and when charged to the proper division of shop expense, would appear as follows:

Tool Expense	$50,967.39
Material Expense	673.07
Power Expense	78.47
Other than Shop Accounts	125.29
Total Adm. and Clerical Exp	$51,844.22

These comprise the so-called service transfers, by which all shop administration expense is closed out into one or another of the divisions of expense mentioned above.

Basis of Man-Hours.—In distributing administration expense, it should be kept in mind that while this distribution is made on the basis of the number of employees, it does not necessarily follow that it is to be made on the basis of the total number of employees that appear on the books of the payroll department for the year. By this I mean that in the event that one department has a labor turnover of 500 per cent each year as compared with only 250 per cent in other departments, an error would be made in using the total number of employees as a basis for distributing this administration expense. Therefore, if two departments of the factory both maintain a normal working force of 100 employees, not the labor-turnover factor should be considered as a factor, but rather the total number of man-hours of each department. Consequently, while the basis of administration expense distribution is employees, in its final analysis it really resolves itself down to a distribution on the basis of man-hours.

Inter-Transfers.—In considering the various divisions of shop expense with regard to service trans-

fers, it is rather difficult to consider them in any definite sequence with respect to the service transfers. The reason is that (as was seen from the analysis of the shop administration expense just made) the service transfer from rent expense has already been incorporated in the grand total for administration expense, while, on the other hand, rent expense itself has not as yet been discussed. This is due to the transfers that have to be made between these various divisions of Shop Expense for service rendered by one division to another, as in the case of floor space used by the administrative branch of the shop. It will be seen later that such inter-transfers take place between the power plant and the manufacturing departments, the power plant and the material departments, power plant and rent service, and so on until all the items of expense—irrespective of their origin—are eventually allocated. As administration expense is all closed out, leaving no balance, it offers possibly the easiest starting point, and for that reason I have chosen to consider it before any other divisions of Shop Expense.

CHAPTER XIII

POWER-EXPENSE ANALYSIS AND DISTRIBUTION

Power Expense.—All expense incurred in connection with the generation, distribution, and transmission of power is called Power Expense. It can usually be divided into about six distinct parts similar to those made in the treatment of permanent fixtures pertaining to power in Chapter II. These six divisions, it will be remembered, were

Steam-Generating Expense
Steam-Distributing Expense
Electric-Current-Generating Expense
Electric-Current-Distributing Expense
Transmission Expense
Compressed-Air Expense.

Many manufacturing plants that generate their own power make the mistake of simply calling all of this expense power expense, regardless of how it is incurred. In the modern plant, however, special attention is given to each phase of power—generation, distribution, and transmission—in order that the management may know whether the company is profiting by making its own power rather than by purchasing it. Still another reason for segregating power expense according to the kind of power generated and

distributed, is that the different kinds of power are chargeable against the manufacturing departments on the bases of different units. For example, steam expense is distributable on the basis of the number of pounds of steam used, electric current, on the number of kilowatt hours, and compressed air on the basis of the number of cubic feet. In order, therefore, to know the exact cost of each unit of power generated and distributed, the expense so incurred must be classified according to these respective systems.

This emphasizes the importance of classifying power equipment according to these divisions, on which point considerable emphasis was laid in the chapter on the classification of plant accounts. Owing to the fact that a large portion of the total for power expense is made up of charges for depreciation, insurance, and taxes, and because these so-called fixed charges are distributed on the basis of the face values of power-plant equipment as included under permanent fixtures pertaining to power plant, the importance of correctly classifying all power-plant equipment according to the respective generating and distributing system will be readily seen.

Mechanical-Equipment Expense, and Labor.—Of late years, great progress has been made in piping steam from large central generating stations and selling it at so much per thousand pounds, very much in the same way as electric current, water, and gas are sold. Moreover, this change has made the compilation of power-cost data a matter of the highest importance to the factory management. Of course, it is not always possible to buy power, nor is it

always advisable to do so, even when an apparent saving will result. These, however, are questions which the management must decide in each individual case, but whether power is purchased or generated by the plant itself, a proper control cannot be exercised unless the facts are presented in a way to make this control possible.

In the case of power plants employing more than 500 horse-power, it is expedient that special attention be given to the handling of coal and ashes and to the expense incidental thereto. Of late years, the introduction of mechanical stokers, conveyors, and various kinds of improved devices for the better handling of coal and ashes on a large scale, have reduced the cost of labor to a much lower point than had been previously thought possible. In consequence, this phase of power-plant expense has attained a higher degree of importance, and data must now be available to make possible the proper control over it. It must be borne in mind that while on the one hand, fixed charges and repairs of such mechanical equipment will show an increase, on the other hand a lower cost of operation may be made possible by the greater reduction in cost of labor and other items. Therefore, a comparison should be made at stated intervals between the increased expense on the one hand for mechanical equipment, and for the reduction of labor on the other.

Shrinkage in Coal.—One item, not always considered, is the so-called shrinkage or loss of "life" in coal stored in bins and exposed to the air. This shrinkage in the coal is due to the gradual produc-

tion and diffusion into the air of carbon dioxide. Such loss is now prevented in some of the larger plants by storing the coal in tanks under water. Lastly, as further items of power expense, we may figure wharfage on coal barges, when coal is delivered by water, and demurrage when delivered by rail.

It may be interesting at this point to show how much of the heat inherent in the coal as it enters the furnace is eventually used, either for the production of useful power or for heating purposes. Mr. Myers, in his book on "The Power Plant,"* has stated that under the best conditions steam in the boiler represents 58 per cent of the heat of the coal which has been consumed to produce that steam. As this steam passes through piping to the engine, 1.7 per cent of this 58 per cent is lost, which results in a delivery to the engine of only 57 per cent of the original heat of the coal. Eliminating the power used in overcoming the engine friction, which is less than 0.4 of 1 per cent of the heat entering the engine, and using the formula that the mechanical energy on the fly wheel equals 7.3 per cent of the heat supply at the throttle, we find that 7.3 per cent multiplied by 57 per cent equals 4.16 per cent. That is, of the heat of the coal supplied to the furnace, 4.16 per cent is converted into work at this point. As the mechanical energy of the engine has absorbed 7.3 per cent of the heat applied at the throttle, the exhaust steam will still retain 92.7 per cent of the heat of the steam as it enters the engine, or 92.7 per cent multiplied by

* Volume 2, Factory Management Course.

57 per cent, which equals 52.8 per cent of the heat of coal that is applied to the furnace.

Now, 52.8 per cent of the heat of the coal enters the feed-water heaters, and this amounts to 88 per cent of the heat of steam entering the engine, or 86.5 per cent of heat of steam from the boiler. Deducting from this 8 per cent for the amount of steam absorbed by the feed water, we find that 78.5 per cent of the heat of steam from the boiler leaves the feed water heater, or only 45.5 per cent of the heat in the coal to the furnace. It is commonly found that one half of this is wasted, so that the heating system receives 22.75 per cent of the heat of the coal to the furnace, of which about 6.75 per cent is radiated, and 16 per cent is discharged, only a small part of which is recovered in the drip.

I have purposely used these figures of Mr. Myers in detail to show the importance of making a detailed analysis of power expense in order that waste, whenever or wherever it occurs, may be easily located and controlled.

Transformer Losses.—The transformer losses constitute still another important point to consider when making comparisons between the cost of power generated and the corresponding cost of power purchased. These are especially to be considered in Western cities, where power is purchased from central distributing stations, and where the current is transmitted over a long line at a high voltage and sent through stepdown transformers. In such cases, the rates quoted by the supplying companies very often are figured on the basis of the power as

POWER EXPENSE SUMMARY.

Depreciation of:	
Steam Generating System	$ 1,213.75
General High-Pressure Steam Distributing System	120.00
General Low Pressure Steam Distributing System	204.30
Electric Current Generating System	906.30
Electric Current Distributing System	360.00
Compressed Air System	261.30
Transmission System	1,997.53
Electric Illuminating System	444.20
Insurance on:	
Steam Generating System	3.29
General High-Pressure Steam Distributing System	.27
General Low-Pressure Steam Distributing System	.55
Electric Current Generating System	2.46
Electric Current Distributing System	1.10
Compressed Air System	.82
Transmission System	5.48
Electric Illuminating System	1.10
Taxes on:	
Steam Generating System	9.17
General High-Pressure Steam Distributing System	.76
General Low-Pressure Steam Distributing System	1.53
Electric Current Generating System	6.88
Electric Current Distributing System	3.06
Compressed Air System	2.29
Transmission System	15.29
Electric Illuminating System	3.06
Rent: Engine Room / Boiler Room Service Charge Transferred from Rent Expense.	1,775.29 / 940.84
Coal	5,492.37
Wharfage on Coal Boats	31.64
Cartage on Coal	890.55
Supplies:	
Oils	262.80
Waste	151.76
Unclassified	33.92
Electric Illuminating System	267.47
Water Purchased	414.56
Repairs and Changes to:	
Steam Generating System	226.98
General High-Pressure Steam Distributing System	22.58
General Low-Pressure Steam Distributing System	16.26
Electric Current Generating System	169.65
Electric Current Distributing System	67.27
Compressed Air System	48.98
Transmission System	372.80
Electric Illuminating System	35.15
Power Purchased:	
For Power	255.61
For Illumination	115.92
Depreciation, Insurance and Taxes on Shop Fixtures	6.04
General Administration Expense (Service Charge transferred from Administration Expense)	78.47
Salaries:	
Chief Engineer (Part)	1,440.00
Assistant Engineer	1,248.00
Oilers and Wipers	1,754.15
Firemen	948.75
Grand Total Power Expense	$22,632.30

measured by meters located at some point before the transformer loss takes place. Unless this fact is taken into consideration, an apparent saving for purchased power may be more than offset by losses that take place in the transformer. It is therefore of paramount importance that when such comparisons are made the factory management advise themselves as to whether or not the quotations of the power company include the transformer losses.

A Power-Expense Summary.—On page 293 is a specimen power-expense analysis made according to these various systems, which includes the service charges transferred from rent expense for the square feet of floor space occupied by the power plant.*

These charges for floor space occupied include not only the actual areas used by boilers, generators, and so on, but also all the surrounding space necessary for the storing of coal which is to be stoked, and such additional space as is used directly or indirectly by the power plant. The rule for assessing aisle space does not apply in cases of this kind.

Dividing this total power expense up among the various systems on the basis of the direct charges that have been made thereto, and charging each system with its proportionate amount of rent expense based on the square feet of floor space used, we find the total of power expense by systems would then be as follows:

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* The figures for this power expense analysis, and also the power tables which follow are taken from "Shop Expense Analysis and Control" by N. T. Ficker, *The Engineering Magazine Co.*, New York.

STEAM GENERATING EXPENSE.

Power Expense, Steam Generating System, refers to all expense relating to boilers, fittings, and pipings for steam used within the boiler room.

Depreciation of Permanent Fixtures........	$1,213.75
Insurance on Permanent Fixtures...........	3.29
Taxes on Permanent Fixtures..............	9.17
Rent	940.84
Coal	5,492.37
Wharfage	31.64
Cartage of Coal......................	890.55
Water	414.56
Repairs and Changes to Permanent Fixtures.	226.98
Administration	39.23
Salary, Chief Engineer (Part)...........	360.00
Salary, Firemen......................	948.75
Total Direct Expense..................	$10,571.13
Transfers to Other Accounts (Steam Distributing System).........................	*10,571.13*
Balance	$ 0.00

Total Pounds of Steam Generated in the Boiler Room.........	25,931,500
Cost per 1,000 pounds..........	$0.408

The steam having been generated, it must be distributed—the live steam being used for manufacturing purposes, and the exhaust steam for heating. Consequently a transfer must be made, closing out all of the steam-generating expense into steam-distributing expense as a service charge. The direct charges to steam-distributing expense, together with the service charge for steam purchased from the steam-generating system, will then appear as follows:

General High-Pressure Steam Distributing Expense.		
Power Expense, General High-Pressure Steam Distributing System, refers to all expense relating to piping, fittings, etc., from the connection with the main feed piping to the local permanent connection where the steam is used.		
Depreciation of Permanent Fixtures..........		$ 120.00
Insurance on Permanent Fixtures............		.27
Taxes on Permanent Fixtures................		.76
Repairs and Changes to Permanent Fixtures.		22.58
Total Direct Expense..................		$ 143.61
Service Charges—Steam Generating Expense.		10,571.13
Grand Total Steam Generating and Distributing Expense....................		$10,714.74
Transfers to other Accounts:		
Electric Current Generating System	*$7,928.91*	
Material Expense..............	*594.67*	
Tool Expense..................	*2,191.16*	*$10,714.74*
Balance		$ 0.00
Cost per thousand pounds of steam distributed..................	$0.414	

On the basis of estimates furnished by the chief engineer, this cost of steam ($10,714.74) is transferred to the electric-current-generating system, material expense, and tool expense, in a ratio directly proportional to the steam each has used. The figures are derived as shown here:

DISTRIBUTION OF STEAM EXPENSE ON CONSUMPTION BASIS

Steam Used by	Lb. of Steam	Expense	Chargeable to
Elec. Cur. Gen. System...	19,188,850	$ 7,928.91	El. Cur. Gen. Exp.
Steam Hammers.........	1,944,875	803.60	
Nickel Plating and Washing Tanks.............	1,439,255	594.67	
Special Pump for Pressure Tests..................	479,775	198.22	Tool Expense $2,191.16
High Pressure Pumps....	479,795	198.22	
Oil Pump for Foundry....	335,890	138.76	
Vacuum Pump..........	383,865	158.58	
Misc. Mfg. Purposes.....	239,940	99.11	
Freight Elevator Pumps..	1,439,255	594.67	Material Exp.
Total.............	25,931,500	$10,714.74	

A study of these power figures will show the importance of such a segregation of power consumption. For example, from the viewpoint of allocating the steam charges between those which can be charged to electric current generation and those which are chargeable as either tool or material expense, it will be seen that of the total steam expense ($10,714.74) only $7,928.91 or about 80 per cent, is used for further power generation. The rest is used for other manufacturing purposes.

The direct and service charges to electric-current-generating and distributing expenses respectively, are obtained by much the same method as that followed in the steam system. These charges are shown on page 298.

ELECTRIC-CURRENT-GENERATING EXPENSE.

Power Expense, Electric-Current-Generating System, refers to all expense relating to engines, dynamos, switchboards, condensers, and piping.

Depreciation of Permanent Fixtures	$	906.30
Insurance on Permanent Fixtures		2.46
Taxes on Permanent Fixtures		6.88
Salaries:		
Chief Engineer (Part)		360.00
Assistant Engineer (Part)		936.00
Oilers and Wipers		1,315.61
Supplies:		
Oil		197.10
Waste		113.82
Unclassified		33.92
Administration		29.43
Depreciation. Insurance and Taxes on Shop Fixtures (Oil Tanks, etc.)		6.04
Power Purchased (For Power)		255.61
Repairs and Changes		169.65
Rent		1,729.41
Total Direct Expense	$	6,062.23
Service Charges (Steam-Generating Exp.)	$	7,928.91
Total Electric-Current-Generating Expense	$	13,991.14
Transfers to Other Accounts		*13,991.14*
Balance	$	0.00

ELECTRIC-CURRENT-DISTRIBUTING SYSTEM.

Power Expense, Electric-Current-Distributing System, refers to all expense relating to main distributing cables and wiring from feeder switch terminals in engine room, up to and including the first centers of distribution in each building, and from there to the permanent terminals at the controlling apparatus, or their equivalents.

Depreciation of Permanent Fixtures..........		$ 360.00
Insurance on Permanent Fixtures...........		1.10
Taxes on Permanent Fixtures...............		3.06
Repairs and Changes to Permanent Fixtures.		67.27
Total Direct Expense..................		$ 431.43
Service Charges (Electric Current Generated)		13,991.14
Total Electric-Current-Generating and Distributing Expenses...............		$14,422.57
Transfers to Other Accounts:		
Transmission System.........	*$10,841.61*	
Compressed-Air System......	*2,013.57*	
Electric-Illuminating System.	*966.53*	
Freight Elevators, Material Expense	*600.86*	*14,422.57*
Balance ....$		0.00
Total Kilowatt Hours Generated and Distributed............	$693,522	
Cost per Kilowatt Hour..........	0.021	

Compressed Air Expense.

Power Expense, Compressed Air System, refers to all expense relating to air compressors, main pipe line to hose or machine connections, headings, etc.

Depreciation of Permanent Fixtures........	$	261.30
Insurance on Permanent Fixtures..........		82
Taxes on Permanent Fixtures..............		2.29
Repairs and Changes to Permanent Fixtures.		48.98
Oils		65.70
Waste		37.94
Salaries:		
Assistant Engineer (Part).............		312.00
Oilers and Wipers......................		438.54
Administration		9.81
Rent		45.88
Total Direct Expense.................	$	1,223.26
Service Charges (Electric Current Distributing Expense)........................		2,013.57
Total Compressed Air Expense.........		3,236.83
Transfers to Other Accounts (Tool Expense).		*3,236.83*
Balance	$	0.00

Transmission Expense.

Power Expense, Transmission System, refers to all expense relating to line and jack shafting and the motors driving same, pulleys, hangers, stringers, etc.

Depreciation of Permanent Fixtures..........	$ 1,997.53
Insurance on Permanent Fixtures...........	5.48
Taxes on Permanent Fixtures...............	15.29
Repairs and Changes to Permanent Fixtures.	372.80
Salary Chief Engineer (Part)..............	720.00
Total Direct Expense....................	$ 3,111.10
Service Charges (Electric urrent Distributing Expense).........................	10,841.61
Total Power Transmission Expense.....	$13,952.71
Transfers to Other Accounts (Tool Expense).	*13,952.71*
Balance	0.00

Electric Illuminating Expense.

Lighting Expense, Electric Illuminating System, refers to all expense relating to distributing mains (light), wiring, arc lamps, pulleys, and other fixtures, incandescent lamps, clusters, stands, rosettes, guards, extension cord, etc.

Depreciation of Permanent Fixtures..........	$ 444.20
Insurance on Permanent Fixtures............	1.10
Taxes on Permanent Fixtures................	3.06
Supplies	267.47
Repairs and Changes........................	35.15
Power Purchased (For Lighting)...........	115.92
Total Direct Expense...................	$ 866.90
Service Charges............................	966.53
Total Electric Illuminating Expense....	$ 1,833.43
Transfers to Other Accounts (Rent).........	*1,833.43*
Balance	$ 0.00

When all these transfers have been made, we find the final distribution of power expense to be as follows:

Tool Expense	$19,380.70
Material Expense	1,195.53
Rent Expense	2,056.07
Total	$22,632.30

This agrees with the total "power expense" as given in the "summary of manufacturing expense" at the beginning of the present chapter, and finishes the distribution of power expense by systems (tool expense being closed out into machine expense). The summary of all power expense by systems would then be:

General Summary of Power Expense.	
Steam-Generating System	$10,571.13
Steam-Distributing (High-Pressure) System	143.61
Steam-Distributing (Low-Pressure) System	222.64
Electric-Current-Generating System	6,062.23
Electric-Current-Distributing System	431.43
Compressed-Air System	1,223.26
Transmission System	3,111.10
Electric-Illuminating System	866.90
Total Power Expense	$22,632.30

Value of Analysis.—An analysis of this kind will bring forcibly to the attention of the management excesses in cost of either generating or distributing power. Furthermore it will provide a means of establishing the unit costs of generating and dis-

tributing either steam, electric current, or compressed air. These unit costs can then be used in charging the various manufacturing departments of the shop with their proportionate expense for the power that they have consumed. For example, while all the steam-generating expense in the analysis made herein has been transferred to the steam-distributing system, not all of this steam has been distributed to the electric-current-generating system, but part of it has been transferred to material expense and part to tool expense.

Power Service Transfers.—The material-expense transfer is made because some of the steam was used in some way in connection with material, while the tool-expense transfer represents such steam as might be used by the manufacturing departments for operating steam trip-hammers or other mechanical apparatus using direct steam power. In the same way we find that not all of the electric current which was generated and distributed was used to operate the mechanical-transmission system (live shafting), since part of it was used in compressing air, part for electric illimination, and part for other purposes. This distribution can be seen by referring to the analysis of Electric-Current-Distributing Expense. It will be seen that in this way inter-transfers are made between these various systems until each is charged with the cost of the power that it buys from another system, and finally all of this expense is closed out into either Tool Expense, Material Expense, or Rent Expense.

The rent expense in this case represents the propor-

tionate amount of exhaust steam used for heating. It will therefore be seen that from an expense-distribution viewpoint, an analysis of power expense made according to these systems, is of paramount importance, not only from a waste-control standpoint, but also from an expense-distribution standpoint. After it is once known that every thousand pounds of steam costs $.408, it is then a very simple matter to charge each department or system with its proportionate share on the basis of the amount of power it uses. In the same way, after we once know that it costs $.021 per kilowatt hour for electric current generated and distributed, to determine the charge to each department on the basis of the power used as shown by the wattmeters, is a simple matter.

Reading the Watt Meters.—Before passing on to the next division of expense, it might be worth while to point out the possibilities of executive control which can be obtained by a systematic reading of the watt meters on the main switchboard in the power plant. In almost all cases, a study of the readings taken from such watt meters will show decided fallings-off in power used, due to slack periods on the part of machine operators. This usually occurs an hour or so before the noon lunch period, or at the close of the day, and results from operators' making their jobs last as long as possible, or from washing-up. A drop may take place in the same way at other times during the day, owing to breakdowns or waiting for work. But whatever the causes may be, they will be instantly reflected on the meter and by a graph plotted from these readings. A watt meter

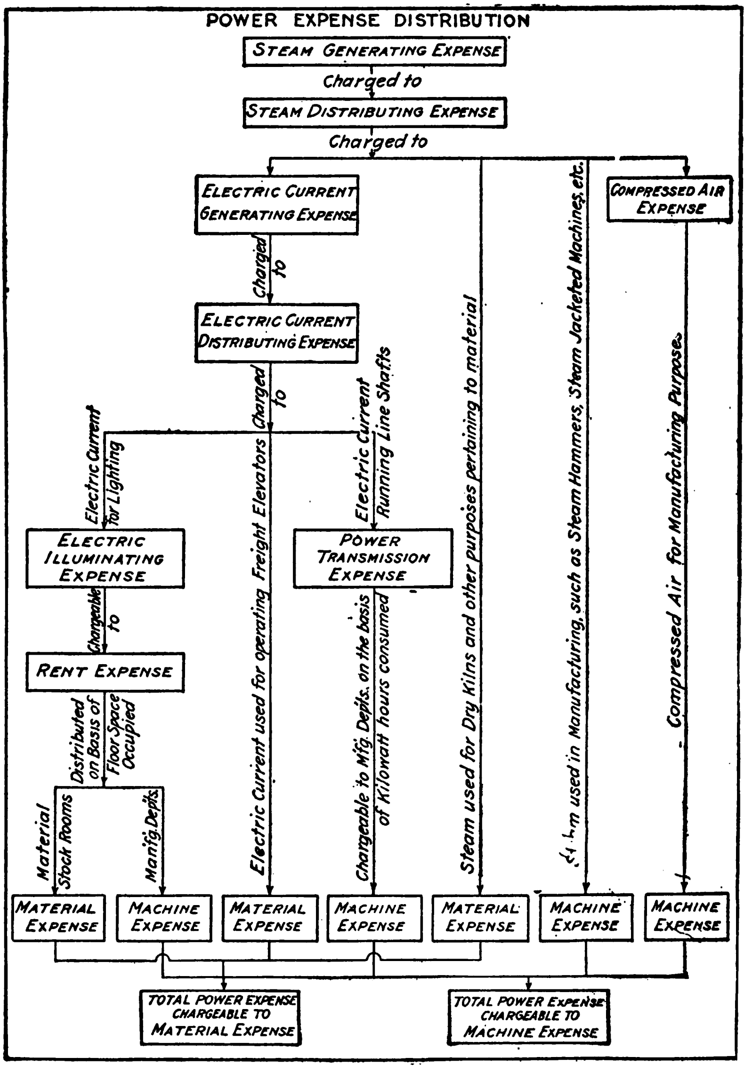


FIG. 74. SHOWING HOW POWER SERVICE TRANSFERS ARE EVENTUALLY CLOSED OUT INTO EITHER MACHINE OR MATERIAL EXPENSE

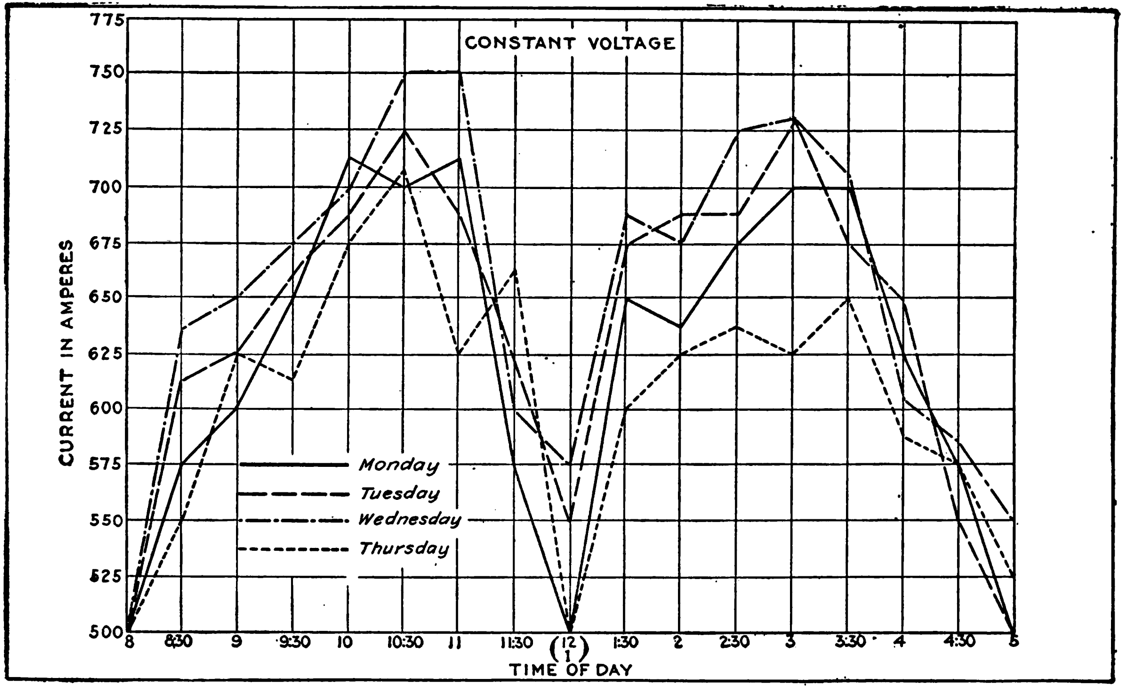


FIG. 73. DAILY GRAPHS OF FLUCTUATIONS IN CURRENT CONSUMPTION

installed in each manufacturing department will show just when the greatest losses are occurring in each department. Comparisons can then be made, and the attention of the department foreman can be called to the waste. If a recording watt meter is not installed the ammeter on the main switchboard in the dynamo room will serve fairly well for making these observations when the voltage is more or less constant. Readings, when taken from the ammeter, at half-hour intervals, will reflect the shop conditions quite clearly. In my opinion—and I have used this method of detecting shop leaks many times—it provides a source of information which will bring to light many factors that could not very well be detected by observation. Figure 73 shows how these fluctuations in electric-current consumption can be indicated graphically, and Figure 74 shows an example of how power expense is finally closed out into either machine or material expense.

CHAPTER XIV

RENT-EXPENSE ANALYSIS AND DISTRIBUTION

Apportionment of Rent Expense.—In our analysis of administration and power-expense charges as divisions of manufacturing expense, we have found that different modes of procedure are necessary in each case. Thus, administration expense was seen to be distributable to production centers on the basis of the number of employees in each center, whereas power expense is distributable on the basis of units of power. In similar manner rent expense, which will now be analyzed, is apportioned on the basis of the amount of floor space occupied. The unit of distribution, therefore, is the square foot—the method to be followed in determining this charge per unit is given below.

The Two Parts of Rent Expense.—Rent expense as I have defined it in my book on "Shop Expense Analysis and Control" (Engrg. Mag.) may be divided arbitrarily into two parts: (a) Fixed Charges pertaining to Grounds, Buildings, and "Rent Permanent Fixtures," by which latter is meant all permanent fixtures connected with the buildings, and (b) Annual Maintenance. Under (a) are properly included:

1. Depreciation on all buildings.
2. Depreciation on "rent permanent fixtures," which includes such permanent fixtures as are common to the whole building.
3. Insurance on all buildings and on "rent permanent fixtures."
4. Taxes on grounds, with the exception of such as may properly be termed "surplus;" that is, grounds purchased in view of future requirements, and which are not at the present time used.
5. Taxes on buildings, together with those on "rent permanent fixtures."
6. Interest on investment. This consists of interest computed at a reasonable rate on the face value of grounds (exclusive of "surplus") on buildings, and on "rent permanent fixtures," less all depreciation on plant written off to date. Mortgages or bonds outstanding against the property should not be deducted.

Under (b), Annual Maintenance, the following items of expense would appear:

1. Salaries of janitors, sweepers, cleaners, watchmen, passenger-elevator operators, fire brigade, etc.
2. Lighting (depreciation of lighting plant, or proportion of power consumed in lighting).
3. Fuel for heating.
4. Repairs to buildings.
5. Repairs to "rent permanent fixtures."
6. Changes to buildings and "rent permanent fixtures."
7. Written off buildngs and "rent permanent fixtures."
8. House-service supplies, as soap, towels, toilet, and janitor supplies.

If the rent expense is summarized according to these two divisions, and applied separately against the total number of effective feet of floor space, a rate

per square foot will be obtained for both fixed charges and maintenance. Comparisons may then be made between the expenses of different periods, and any abnormal variations will easily be located. The rent cost per square foot would therefore include both fixed charges and maintenance expense. For leased buildings it would be the rent paid plus the maintenance.

Determining Effective Floor Space.—In order to ascertain the total effective floor space, the following items must be considered: All the space in buildings which could be utilized for factory, office, or warehouse purposes, including aisles, engine and boiler rooms, toilet rooms, stairways, elevator shafts (but not light shafts), pillars and walls; all open yards used in the carring on of the manufactory's business, including such space as might be used for the storage of raw material, scrap and so on, and also any roofs used for such purposes; and all driveways, courts, and railroad tracks owned by the company, and used for shipping or receiving merchandise.

When buildings are rented, the total annual rent charged to expense should include (a) annual rent paid; and (b) annual maintenance, which is not included in rent paid.

Rent-Expense "Classification List."—In a previous chapter I designated the Shop Expense Account as Account No. 20. For sub-classification purposes all numbers from 001 to 099 inclusive were assigned to Administration Expense; all from 100 to 199 to Power Expense, and all from 200 to 299 to Rent Expense. A classification reference list for Rent Expense would be made up about as follows:

RENT EXPENSE

CLASSIFICATION REFERENCE LIST

201—Changes to buildings and "rent permanent fixtures."

202—Depreciation on buildings and "rent permanent fixtures."

203—Drawings and surveys.

204—Inspection and supervision of maintenance of buildings and fixtures.

205—Interest on investments in grounds, buildings and "rent permanent fixtures."

206—Renting other buildings.

207—Repairs to buildings and street paving.

208—Repairs to "rent permanent fixtures."

209—Repairs and inspection of passenger elevators.

210—Supplies for cleaning.

211—Supplies for fire protection (not including apparatus).

212—Supplies for watchmen (oil, lanterns, etc.).

213—Stationery.

214—Salaries, attendants to heating system, fire brigade, etc.

215—Salaries, passenger-elevator operators.

216—Salaries, pumping station (fire and house service)

217—Salaries, sweepers.

218—Salaries, ushers, and watchmen.

219—Taxes on grounds, buildings, and "rent permanent fixtures."

220—Watch-box service.

221—Water (other than manufacturing).

222—Unclassified rent expense.

223—Service charges for light (brought forward from power expense and gas expense).

224—Service charges (brought forward from administration expense).

225—Transfers to other accounts (credits).

We have previously referred to the Shop Expense Account as Account No. 20, and as rent expense is merely one of the divisions of shop expense, by using the reference list of sub-classifications we should classify charges belonging to any kind of expense from these classification numbers. For example, "Renting of Other Buildings" would be classified 20-206, in which 20 would denote the account number, and 206, being in the two hundreds, would immediately identify the charge as a rent expense item; the particular item would be obtainable by reference to the classification list.

Transfers.—To the direct charges to rent expense as made during the course of the year, transfer must now be made for "service charges" from other divisions of expense. For example, a transfer must be made from that division of manufacturing expense known as "fixed charges" for the proportion of depreciation, insurance, and taxes chargeable to buildings and "rent permanent fixtures," and for taxes on "grounds," as these form part of the rent expense. Similarly, transfers must also be made from "power expense" to "rent expense" for electric illumination and so on. The sum of these service charges and the direct charges will give the total charge to rent.

Analysis of Annual Rent Charge.—As we are interested in determining a rent rate per square foot for both fixed charges and maintenance, as included under rent expense, we shall analyze the annual rent charge of $54,363.20, as shown in the summary at the beginning of the preceding year, and this gives us the statement shown on page 313.

STATEMENT OF ANNUAL RENTAL EXPENSE AND COST OF EFFECTIVE FLOOR SPACE FOR THE YEAR 1915.

Fixed Charges:		
Depreciation on Buildings and Rent Permanent Fixtures..	$ 5,686.96	
Insurance on Buildings and Rent Permanent Fixtures.......	27.10	
Taxes on Buildings and Rent Permanent Fixtures.......	104.86	
Interest on Investment in Grounds, Buildings, and Rent Permanent Fixtures (Figured at 5% of Net Values)	7,279.33	
Rental of (2) Buildings from A. B. C. Realty Co........	25,000.00	$38.098.25
Maintenance:		
Repairs and Changes to Buildings	$ 4,419.74	
Repairs and Changes to Rent Permanent Fixtures........	110.83	
Salaries Watchmen and Doorkeepers	2,103.05	
Salaries Sweepers and Cleaners.	3,852.50	
Salaries Yardmen.............	780.00	
Water (House Service)........	1,872.17	
Fire Protection Expense.......	493.50	
Supplies for Cleaning..........	169.25	
Gas Purchased.................	1,031.84	
Electric Illuminating Expense — Power purchased.	115.92	
Electric Illuminating Expense — Power generated.	966.53	
Electric Illuminating Expense — Supplies	267.47	
Drinking Water Expense.......	82.15	$16,264.95
Total Annual Rent Cost.............		$54,363.20

A summary of the floor space against which this is applicable is:

Power plant	5,292	sq. ft.
Material	21,846	"
Manufacturing	29,453	"
Administration and clerical	4,723	"
Shipping	4,840	"
Engineering and drafting	982	"
Total occupied space	67,136	sq. ft.
Unoccupied space	38,777	"
Grand Total Floor Space	105,913	"

For this 105,913 square feet of effective floor space we have "fixed charges" of $38,098.25, or $0.3597 per square foot, and "maintenance charges" of $16,264.95, or $0.1536 per square foot, giving a total rental cost per square foot of $0.5133.

Transferring Charges.—With the rent expense rate of $0.5133 established, transfers can now be made to power expense, on the basis of floor space occupied by the engine and boiler rooms; to material expense, for space used by storerooms; and to machine and tool expense, for space used for manufacturing purposes. The charge in each case, of course, is obtained by multiplying the number of feet of floor space occupied by the rate of $0.5133. The amount of rent expense assessable against unoccupied space should be transferred out of the shop expense account to one of the general expense accounts of the company. This also applies to shipping and engineering expenses and to any other charges for shop space occupied by other than shop departments.

Total Annual Rent Cost......		$54,363.20
Transfers to:		
Power Expense............	$ 2,716.38	
Material Expense..........	11,213.55	
Tool Expense..............	15,118.22	
Administration and Clerical Expense	2,424.31	
Shipping Expense..........	2,482.45	
Engineering and Draughting	504.06	$34,458.97
Balance		$19,904.23

This balance is equal to the charge against 38,777 square feet of unoccupied floor space.

By this method, as given above, a basis of comparison can be established between the rent expense of different periods, and this may be utilized for determining the advisability or non-advisability of the purchase, rental, or erection of new buildings. It may be also a means for bringing into clear perspective another point which does not always receive the proper amount of attention, namely, the actual expense involved through carrying surplus space. I have known such an analysis to result in an entire rearrangement of production centers and storage space, so that the excess floor space could be rented, and thus produce an additional income by no means to be despised.

As stated with reference to the other expense charges, the method herein given is, of course, subject to modification to meet existing conditions at the plant in question. At times, a much more elaborate classification and a more elaborate analysis may be

required. For example, the item "Water for House Service" has been given but one sub-classification (221) in the reference list of classifications, but in some very extensive manufacturing establishments, such as steel mills, railroad repair shops, or brass mills, the charge for water expense chargeable to rent alone, might have to be divided into as many as five distinct classes, as: (a) Fire protection, hydrants and sprinklers; (b) grounds service; (c) house service for toilets; (d) drinking water; (e) high-pressure service for power for elevators. These would use classification numbers from 230 to 249 inclusive. When such divisions are necessary, the expense is distributed to the various systems on the basis of cubic feet of water used, as indicated by the meter readings. When this is not possible, the distribution is made on the basis of estimated consumption.

Expense of Generating Gas.—As mentioned previously, light or illuminating expense is chargeable to rent, and this brings before us another factor which presents itself in certain plants: namely, that of generating gas. When illuminating expense is charged to rent, the classification of expense incidental thereto should be made in a manner similar to that shown below:

GAS GENERATING EXPENSE

250—Accidents
251—Belting on machine
252—Changes to gas plant
253—Depreciation on generating, purification, and distributing equipment, and buildings
254—Generator fuel (coke, coal, etc.)
255—Enrichers (oil, etc.)

256—Purification materials (iron oxide, shavings, etc.)
257—Rags, oils, cleaning supplies, waste, etc.
258—Repairs to buildings and fixtures
259—Repairs to machinery and tools
260—Insurance
261—Taxes
262—Wages of gas maker and assistants
263—Wages of clinker and ashmen
264—Inspection expense
265—Service charges (brought forward)
266—Transfers to rent (class No. 223) and other accounts (credits)

The reason for the assignment of the above to the 200 class, is that practically all of this expense is finally closed out into rent expense, of which it really forms a part, because the gas generated is used for illumination purposes. If any of the gas is distributed for manufacturing purposes, and is used in gas ovens, heaters, blow pipes, and so on, it would be chargeable to "machine and tool expense" through the transfer classification No. 266.

Care and Upkeep of Grounds.—Of late years, manufacturers are seeing more and more clearly the importance of attractive surroundings for their works, not so much from an esthetic point of view as from the cold fact that they add a very decided inducement to labor and are conducive to sanitary conditions in all departments. It has long been amply proved that large, well-ventilated, and well-lighted rooms give a result of increased efficiency on the part of the workmen, and it is now being recognized that if the outlook from the factory is over large, well-kept, green

lawns with here and there a dotting of shrubbery, the additional expense involved will be repaid many-fold by an increased efficiency within the factory.

All this gives rise to another division of expense chargeable to rent: that is, "care and upkeep of grounds." Many of the larger plants have laid out tennis courts, baseball diamonds, and running tracks, and find wonderful results accruing through friendly competition between different departments. All this, however, entails additional expense, and this expense, like all other, must be controlled in order to ensure the maximum return on the amount involved.

The "care and upkeep of grounds" is chargeable to rent expense, and as these expenses must necessarily be classified, I give a reference list of classifications below:

RENT EXPENSE, "GROUNDS"

275—Changes to fences, driveways, walls, gates, nouses, etc.
276—Depreciation on houses used as part of the grounds
277—Depreciation on fixtures, etc.
278—Insurance on houses, equipments, etc.
279—Repairs
280—Salaries, superintendent of grounds, and watchmen
281—Salaries, care and upkeep of grounds
282—Taxes
283—Service charges—water (transferred from water expense)
284—Service charges—administration (transferred from administration expense)
285—Transfers to rent (closed out into classification No. 221).

This form of expense-segregation, as outlined

above, permits a control over the individual subdivisions of rent expense that is not attainable when all the charges are grouped together under one heading. In small factories, so elaborate a classification may not be desirable, but, on the other hand, in the case of concerns manufacturing on a very extensive scale, an even more detailed analysis may become necessary. The object here has been to indicate the possible ways in which rent expense may branch out, and to show these in their broadest applications.

Floor Space Classified According to Expense.—Let us turn back now to the original summary of rent expense. We found that this amounted to $54,363.20 for 105,913 square feet of floor space, with an equivalent rate of $0.5133 per square foot. It is proper now to classify this space so that an amount proportional to the floor space occupied can be charged to each division of manufacturing expense—as administration, power, machine expense, and so on—and in this way can be eventually closed out into either machine or material expense. The following is an arrangement of floor space by expense classification:

Items Chargeable to Machine and Tool Expense:

Includes space in manufacturing departments occupied by machines and benches, and the surrounding space, including private aisles necessary for their proper operation and maintenance. This space should be accounted for as a balance after all other areas have been deducted from the total area of each department. It should be finally distributed among the various benches and machines, for use in determining a machine rate of expense loading, as will be explained in detail further on in the chapter devoted to the discussion of the Machine Unit System. The tool rooms are also included in this division.

Items Chargeable to Administration Expense:

General and clerical offices (all offices included under shop-administration expense); manufacturing offices of general foreman, foreman, and shop clerks; space occupied by lockers.

Items Chargeable to Material Expense:

Offices pertaining to material; stock rooms, including private aisles; tracks and space occupied by scales (pertaining to material); freight-elevator space; three-fourths of main aisles in the manufacturing and stock departments; receiving rooms; inspection laboratories.

Items Chargeable to Power Expense:

Steam-generating system, including space occupied by boiler room, coal bunkers, ash bins, ash conveyors, etc.; electric-generating system, space occupied by generators, switchboards, etc.; electric-distributing system, space occupied by mains, etc.; transmission system, spaee occupied by motors, shafting, switchboards, etc., other than transmission stock; compressed-air system, space occupied by compressors and piping.

Items Chargeable to Light Expense:

All space taken up by lighting systems.

Items Chargeable to Rent Expense:

Stairways and passenger elevators; one-fourth of main aisles in the manufacturing and stock departments and all of the office corridors; sinks and toilet rooms; vacant space in shop, not in use.

With this classification as a basis, rent expense may be accurately distributed to the several other divisions of manufacturing expense previously mentioned. It is quite essential that these areas should be checked up at stated periods, as extensive changes or removals will affect the cost of production through either excessive or insufficient charges. It is necessary to assign a somewhat higher rate per square foot

for office space than is applied to other space. An analysis of expenses will determine this, and it will be found to average very nearly a ratio of two to three. That is, if regular space costs fifty cents per square foot, office space will be found to amount to about seventy-five cents; this higher cost is caused by the greater amount of labor expended in the cleaning and maintenance of office space.

Purpose of Analyzing Manufacturing Expense.—The purpose of the above analysis and discussion of the subject of the annual rent charge, has been to show as clearly as possible the different ramifications, with their relative importance, of this most important division of manufacturing expense—one that has never been treated in a sufficiently serious way, from a cost point of view, either by manufacturers or accountants. The illustrations used in this discussion are not intended to show methods for use in either very large or very small plants; they are intended to strike a happy medium—methods must be varied to meet the existing conditions of the plant in which they are to be used. In other words, the analysis given are intended to form a basis for reasoning, rather than to establish any fixed lines of procedure.

We have so far considered administration expense, power expense, and rent expense. We now come to the analysis of depreciation, insurance, taxes, and interest charges, which constitute a most important portion of the total overhead. I shall try to make an analysis of certain common errors ordinarily made in computing these charges, and shall endeavor to devise a standard method for determining them.

CHAPTER XV

DEPRECIATION ACCOUNTING

Depreciation the Most Important of Fixed Charges. —In our examination of the three divisions of manufacturing expense which have been already considered, namely, administration, power, and rent charges, we have found them to be distributable to costs of production on the basis, respectively, of the number of employees, the units of power consumed, and the units of floor space occupied.

Under the classification of Fixed Charges, we find Depreciation, Insurance, and Taxes, and these, as we shall learn, are to be computed and distributed on the basis of face values, to the various production centers of the factory. In a former chapter I referred somewhat insistently to the importance of a correct classification of the additions to the factory-plant accounts. A fuller appreciation of the necessity for this will be gained as we come to recognize the fact that the face values of the factory equipment, as shown by the respective plant accounts in the company's general ledger, control absolutely the extent of the expense charges for which they are used as a basis for computation.

Of the three divisions of fixed charges, as noted above, depreciation is far and away the most im-

portant, from a cost viewpoint. Unfortunately, however, it is just the one that has proved the most uncertain and perplexing to manufacturers and accountants—possibly more so than all the other factors of cost accounting combined. It will continue to fill this undesirable role until such time as a standard method shall be devised and put into practice for determining, rather than guessing at, the actual depreciation of buildings and equipment.

Estimating Depreciation on Buildings and Fixtures.—It will be my privilege in this chapter to indicate how the amount of depreciation on buildings and fixtures, even if not calculated with mathematical certainty, may yet be estimated with a much closer approach to accuracy than by the hit-or-miss methods that are so common. As the matter seems to stand at present, manufacturers are a rule unto themselves in the matter of writing off allowances for depreciation. They appear to evolve, each from his own inner consciousness, rules which are based on the merest guess work as to how long buildings and fixtures ought to last. One is almost tempted to hazard the assertion that these guesses are largely governed by the present or prospective state of business, the weather, or the degree of health that obtains in the digestive systems of the gentlemen in question.

This latter statement is not at all intended as a joke. A board of directors of whom I had personal knowledge some years ago, were accustomed to set aside, each year, a reserve for depreciation, which later was charged against the manufacturing branch of the company and included in their cost of produc-

tion. The amounts varied in proportion to the profits of the preceding year, and were also to some extent influenced by the immediate state of mind of these gentlemen. Any idea that depreciation formed a most vital and integral part of their cost of manufacture had evidently never entered their minds, and yet they were constantly determining their selling prices on the basis of their shop costs.

"Estimate" Defined.—Before we go any further, let us clearly understand precisely what we mean by the terms "estimate," and "life of the plant." An estimate may be a guess, pure and simple, founded upon nothing, and, so far as its usefulness is concerned, predicating nothing. But, on the other hand—and it is in this sense that the word is used here—an estimate should be a prediction founded upon a large number of past experiences which have been carefully collated and examined, and from which a reasonably dependable average has been struck.

The most convincing evidence of the accuracy of this form of estimate is found in the records of life insurance. Here the entire basis is that of an estimate of how many years a given person, having already attained a certain age, may still be expected to live. And this estimate, upon which the whole premium schedule depends, is merely an average of the number of years lived by a great number of people who have passed that given age. Of course, in any isolated case there may be an enormous discrepancy between the estimate and the eventuality, but in the main the results are entirely satisfactory.

By the use of the expression, "life" of a plant, no

reference is intended to the length of time through which the buildings or fixtures in question may endure as an entity, but rather to the length of time during which such buildings or fixtures may continue to be of use to the manufacturer. Hence, depreciation must represent to the manufacturer the difference between the cost of the property, and its liquidation value at such time as it shall have become useless to him.

Wear-and-Tear and Obsolescence.—The duration of this period of usefulness is governed by two prime factors:

(a) Actual "wear and tear," and
(b) "Possible obsolescence due to improvement in the art."

The term used to express the first factor is self-explanatory. The meaning of the second will be easily grasped after the consideration of an illustration or two. It is evident that a motor used for the propelling of an aeroplane will become obsolete much more quickly than would a motor in some ordinary commercial use, since the development, in both construction and design, of aircraft motors has been so rapid that it becomes necessary to discard older types long before they have become worn out through actual use. In an establishment that I know, certain types of automatic screw machines with a natural life of from fifteen to twenty years were discarded at the end of three years, to make place for new machines. The latter were so much more efficient than the original ones that the apparent loss from the replace-

ment was much more than offset by the gerater efficiency of the new unit.

In the same manner under certain conditions buildings may become so obsolete at a comparatively early period of their natural life that it proves much more profitable to construct entirely new ones than to continue the use of the older types. Obsolescence, therefore, is a most important factor from a depreciation standpoint, and one which must receive the most careful and discriminating consideration when rates are to be established.

Depreciation Is Actually an Expense.—At this point it is very natural to ask, why, if the determination of depreciation is dependent on so many variable factors, in other words, if it is to such an extent a matter of conjecture—why is it not sufficient to set aside each year an amount which we can be sure will be enough to meet all needs, and thus obviate all further bother with depreciation and rates? The answer is that this method does not take into account the effect on operating costs. It must be recognized from the start that depreciation is precisely as much an expense as power, rent, and taxes, and that it is not, as many apparently regard it, simply a bookkeeping transaction. We may perhaps better realize its effect upon shop costs when we consider that in the average shop the charge to manufacturing expense for depreciation on grounds, buildings, machinery, and tools, computed at fair rates, will amount to about one-third of the total manufacturing expense.

A factory and its equipment, taken together,

present an extremely complex entity which is formed of different units, varying in relative importance, from a file to a six-story building. Each of these units has its own term of life—the file may be discarded in a few hours, the building may endure for a generation—but in the end they both pass away. And between these extremes is an innumerable list of units, each with its own life span, during which it contributes its specific share to the product of the factory as a whole.

Three Factors Govern Any Depreciation Scheme.—We shall find that there are three factors that directly govern any scheme of depreciation:

1. The length of time for which the property is to be used.
2. The liquidation value at the end of that period.
3. The method of creating a reserve to take care of this depreciation; that is, whether uniform or varying amounts shall be set aside annually.

As I have already said, the estimates that must be made, and used as the basis for any scheme of depreciation, can only be in the form of conjecture, tempered by experience. Now, there is not in existence any such considerable body of data relating to the probable useful life of buildings and fixtures as the insurance actuaries possess concerning the probable duration of human life. Nevertheless, there is an amount sufficient to give us a reasonably sure foundation for estimates regarding specific cases. These data will be found tabulated a little further on; the buildings are differentiated according to their construction, and in each case mention is made of the authority for the figures stated. Before entering into

an extended discussion of the factors above noted, I want to emphasize the fact that while depreciation is often looked upon as a form of loss, if we bear in mind one of the first principles of economics, that "production without loss cannot exist." we shall be able to comprehend that "depreciation of the plant" means, to a certain extent, "appreciation of the product."

In considering the three factors which I have stated to be the component parts of any scheme of depreciation, taking them in the order given, we have to take into account the effects of time, as shown in the "wear and tear" and in the obsolescence, which are the factors controlling the "life" of any property. In the case of railroads, the "wear and tear" may be offset by repairs and replacements. In manufacturing establishments, on the other hand, while it is usual to make repairs as required, there is seldom any considerable replacement of parts.

Pacific Gas & Electrical Company's Investigations.—The Pacific Gas & Electrical Company, the Wisconsin Railroad Commission, and others, have made a series of investigations with the object of establishing the "expectation of life" of various forms of building construction. We now have their figures, which afford us a reasonably sure basis for our purpose, although possibly some modifications for immediate conditions may be necessary.

The investigations of the Pacific Gas & Electrical Company have shown that the useful life of buildings constructed wholly of wood may be expected to average 20 years; but this "expectation of life" is

far different in structures in which wood is entirely or largely replaced by other, and more durable, material. For instance, a building of corrugated iron, but with wooden frame and floors, may be considered to possess the same lease of life as the wholly wooden structure; whereas if we substitute a concrete floor for the wooden one, we find that the expectation of life for the building now rises to 25 years. Or, in terms of percentage, the substitution of concrete for wood, for flooring, increases the life of the building by 25 per cent.

Again, if we still retain the wooden floors in our building, but substitute steel for the wood in the frame, we have added another 5 years to the life of the structure, or, in other words, have increased its expectation of life by another 25 per cent. And lastly, having the steel frame for the building, if we now substitute concrete for the wood in the floors, another 6 years is added, making the life of the structure 36 years, or 80 per cent more than the original building, made wholly of wood.

In the case of brick buildings, the investigators have looked into the effect upon the life of the structure of various materials used for roofs and floors. This investigation revealed the following facts:

A brick building with roof and floors of wood may be considered as good for 30 years. With the same floors and a slate roof, 20 per cent is added to the life of the structure, making it 36 years. To the latter figure 4 years may be added by making the roof of corrugated iron, and the floors of concrete.

And the brick structure, with either a slate or reinforced concrete roof, and with concrete floors, may be considered as having an expectation of life of 50 years. It will therefore be seen that the life of a building is greatly affected by the kind of material used.

Findings of Wisconsin Railroad Commission.—The Wisconsin Railroad Commission have determined that the life of a first-class stone-and-brick building should be considered to be 75 years, and the Chicago Telephone Company's investigators place the life of "fireproof" buildings at 40 years.

For tools and shop machinery there is, of course, a good deal of difference of opinion, owing to the variety of conditions under which these investigations were made. But considering these differences of conditions, the results are fairly satisfactory. Thus the Wisconsin Railroad Commission gives as its finding that the life of tools and shop machinery may vary from 5 to 25 years, while the results obtained by the others run from the 12½-year period, as determined by Cooley, to the 20-year limit of Stone & Webb.

"Liquidation" Value.—The "liquidation" value of a property depends largely upon the adaptability of that property to purposes other than the original ones, and also on any "unearned increment" that may accrue by virtue of its location, as sometimes happens in city properties, or along the line of new railroads. But under the most favorable circumstances, the liquidation value of the average plant at the end of its useful life is scarcely more than scrap value, and at times, in its worst phase, it actually

costs a considerable amount to get rid of the worthless property.

The "method" of computing depreciation derives its importance from its possible effect on operating costs. It is sound business practice to approach liquidation value as rapidly as possible, and it is equally good policy to know the real value of property when making up tax reports, or when placing insurance. But it is most vitally important that any depreciation scheme which may be adopted shall be applied with the most careful consideration of its effect on costs of production.

Straight-Line Formula for Depreciation Rate.—For obtaining the "depreciation rate," there are two principal methods, or formulae, in use.

1. The Straight-Line Formula.
2. The Reducing-Balance Method.

By the straight-line formula the annual rate to be written off is obtained by dividing the original value of the property by the number of years which are estimated to form the natural life of that building. Or, reduced to a simple formula, we have

$$x = \frac{V - V'}{n}$$

in which

V = Original investment,
V' = Salvage value,
n = Lifetime in years, and
x = Amount of annual charge.

This formula derives its name from the fact that

if the years of the lifetime and the annual charges are marked off on cross-section paper as ordinates and abscissae respectively, and the points so obtained are connected, the resultant will be a straight line.

Reducing-Balance Method.—The Reducing-Balance Method charges off a constant percentage on the decreasing balance, beginning with the original investment, thus reducing it to salvage. This constant percentage must be such that at the end of a given period of years the investment, less salvage, shall have been written off. In order to obtain the formula for arriving at the amount of depreciation to be written off for any given year, let us assume that

V = The Original Value,
V' = Salvage "
n = Number of Periods,
x = The constant percentage necessary to reduce V to V' in "n" periods, by deducting for each period such percentage from the balance remaining over from previous periods.

Since V equals the original value, its value at the end of the first period will be $V(1-x)$; at the end of the second period the value will be $V(1-x)-V(1-x)x$, which, reduced to its simplest form, is $V(1-x)^2$. Similarly, at the end of the third period, the value will be $V(1-x)^3$. As n equals the number of periods, the balance at the end of the nth year will be $V(1-x)n$. Since this value is that of salvage, we have $V' = V(1-x)n$. If we divide this equation by V, we have $\frac{V'}{V} = (1-x)n$. Extracting the nth root we have

$$1-x = \sqrt[n]{\frac{V'}{V}} \text{ or, } x = 1-\sqrt[n]{\frac{V'}{V}}$$

If, by a process similar to that of the Straight-Line Formula, we lay off for ordinates and abscissae, respectively, the periods and the rate to be written off for each period (which in this case, of course, is constantly a decreasing quantity) we shall, instead of a straight line, obtain a parabola. This might properly be termed, then, the "parabolic formula."

Diminishing Values Important.—The method of writing off depreciation on the basis of diminishing, rather than original, values is based on sound reasoning. During the early life of a property when, by this method, the reserve for depreciation would be high, the repairs would be practically nil; whereas, during the later period of its usefulness, the smaller reserve would be counterbalanced by the higher repair charges. Therefore, by applying rates of depreciation on the net values of the plant, and so making the charge to expense lighter toward the end of the life of the property, the effect on the operating costs would be fairly equalized for all periods. Also, as it is generally true that the efficiency of a plant decreases as the plant grows older, it is only reasonable that the depreciation charge to shop expense should become less as repairs increase.

Depreciation-Repair-Reserve Method.—A method has been adopted in some plants, known as the Depreciation-Repair-Reserve. It consists in estimating the probable life of the property and the repairs for that period. By adding these repairs to the amount for depreciation, and dividing by the estimated years, a flat charge is made each year to manufacturing expense, to cover all repairs and depreciation. Any

increase or decrease for that period is adjusted through a special-adjustment account for that purpose. While this method has its good points, it does not simplify matters as greatly as it would seem to, on its face, on account of the constant adjustments made necessary through new equipment purchases, and on account of the junking and sale of equipment.

English Practice.—The English practice in arriving at depreciation rates on buildings, is to assume that the value of a building is never less than 25 per cent of its original cost. This procedure does not agree with that of American manufacturers and engineers, who view the matter from an entirely different standpoint. In England, where many structures attain a very great age, a building is considered permanent if it consists only of walls, roofs, and floors, provided the floors can still carry a load. The rates of depreciation on buildings that they use, average only about ½ of 1 per cent. Their method of calculation does not take into account the fact that a building may be "too permanent".

The truth of this last statement is well illustrated by the case of the London & North Western Railway, between London and Liverpool. This road was built a great many years ago, when the maximum load of freight cars was ten tons. All construction in connection with cuts, tunnels, bridges, and so on, was made so solid and durable by the use of masonry and stone that when the question came up later of rebuilding the road to meet the more modern conditions, it was discovered that the cost of such rebuilding would be so enormous as to make it prohibitive.

As a consequence, on account of the low carrying efficiency, due to the antiquated form of construction, the freight rates on merchandise between London and Liverpool—a distance of only two hundred miles—is nearly twice the rate for similar goods carried from New York to Chicago, although the latter distance is nearly one thousand miles.

Another error frequently made by English manufacturers consists in charging too low a rate for depreciation. They pay out profits according to the apparent state of their accounts, and find that when it is necessary to bring their equipment up to more modern requirements, it is necessary to bring in new capital.

American Rates of Depreciation.—In American practice the following rates of depreciation on buildings and permanent fixtures devoted to manufacturing purposes have been used with some success.

DEPRECIATION RATES ON BUILDINGS AND PERMANENT FIXTURES.

	Factories	Warehouses
Buildings:		
Modern fireproof steel and tile	3 per cent	3 per cent
Mill construction...........	4 " "	7 " "
Steel construction (only partly fireproof).............	3 " "	6 " "
Wooden buildings (of poor construction)............	8 " "	12 " "
Permanent Fixtures:		
Pertaining to buildings......	8 " "	12 " "
Pertaining to power and lighting plants...............	8 " "	12 " "
Pertaining to material.......	8 " "	12 " "

Power and Lighting Plants.—Since warehouses are not subject to wear and tear due to the constant jar of machinery, to which factory buildings and fixtures are subjected, it is assumed, with reason, that the depreciation of the former class of buildings will be appreciably less than that on the latter class. "Permanent Fixtures Pertaining to Power and Lighting Plants" are considered as suffering greater depreciation than other permanent fixtures, on the principle that they come, more or less, in the same class as machinery, and are therefore subject to more rapid obsolescence. As an illustration of the truth of this last statement, I shall quote from a report made in 1914:

> In 1902 the Interborough Rapid Transit Company of New York installed in its Seventy-fourth street station an engine room full of eight-thousand-horsepower reciprocating engines costing some millions of dollars. They were, at that time, the finest engines in the world, and they were duplicated later in several other plants, well designed, well taken care of. Engineers would have judged them good for a life of 40 to 50 years; but now, inside of 12 years, they have become cumberers of the earth, and at great expense they are being torn down and their foundations blasted out to make room for a series of 30,000 kilowatt turbines.

The following are experience tables adopted by the Manufacturers Cost Conference, the Pacific Gas & Electric Company, and others. The wide variation between the estimates is ample evidence of the small amount of experience data which is available. The compilation of such figures, however, is of value as a means of measuring the extent and gradual reduction of such variations.

STANDARD DEPRECIATION RATES
Adopted by Manufacturers' Cost Conference

	Per Cent on Cost	Per Cent on Reducing Balance
Buildings and accessories:		
Reinforced concrete or steel and tile..	2	3
Brick and steel with non-combustible roof and concrete floors...........	2.5	4
Brick, steel and wood...............	3	4
Brick and wood.....................	3	5
Steel frame, wooden roof and corrugated iron walls..................	3.5	7
Steel frame, non-combustible roof and corrugated iron walls.............	3	6
Concrete block, with wooden roofs floors............................	3.5	8
All wood structures, well built (20 years).........................	4.5	10
All wood structures, cheap (20 years)	5	12
Sprinkler system (20 years).........	4	7.5
Heating and ventilating system (20 years).........................	4	7.5
Water and sewer piping and sanitary fixtures (where separate)..........	4	7.5
Tanks and reservoirs, steel..........	4.5	10
Tanks and reservoirs, wood (20 years)	9	20
Machinery and large equipment:		
Boilers, pumps, feedwater heaters and air compressors..................	6	15
Power piping.......................	6	15
Switchboards, main wiring and conduit............................	6	15
Engines and dynamos...............	5	10
Machinery, motors, machine tools, traveling cranes, etc..............	4.5	10

STANDARD DEPRECIATION RATES
Adopted by Manufacturers' Cost Conference

	Per Cent on Cost	Per Cent on Reducing Balance
Punch presses, bending rolls, power shears and drop hammers	4.5	10
Machine tool accessories—boring bars, drivers, key seating broaches, etc.	50	
(All renewals to repairs.)		
Cupolas, converters, melting furnaces and accessories	5	10
Annealing and heating furnaces, ovens, forges, etc.	5	10
Motor trucks	20	60
Storage battery locomotives (battery renewals to repairs)	10	30
Horses and wagons	12	35
Small tools:		
For machines, net additions	50	
Hand tools, net additions	50	
Punches and dies (standard), net additions	50	
Chills, iron and steel flasks and accessories, net additions	50	
Fixtures, furniture and miscellaneous equipment:		
1. Steel shelving, lockers, etc.	5	12
2. Mechanical applicances, net additions	60	
3. Departmental wiring and electric fixtures, net additions	60	
4. Miscellaneous items (wood) net additions	70	

THE PROBABLE USEFUL LIFE OF VARIOUS FORMS OF BUILDING CONSTRUCTION.

Construction	From Investigations By	Probable Life
Wooden	Pacific Gas & Electrical Co.	20 years
"	Rosecrans	25 "
Corrugated Iron:		
Wooden Frame and Floor	Pacific Gas & Electrical Co.	20 "
" " Concrete Floor	" " " " "	25 "
Steel " Wood "	" " " " "	30 "
" " Concrete "	" " " " "	36 "
Brick:		
Wood Roof, Wood Floor	" " " " "	30 "
Slate " " "	" " " " "	36 "
Cor. Ir. " Concrete Floor	" " " " "	40 "
Slate " " "	" " " " "	50 "
Reinforced Concrete Roof, Concrete Floor	" " " " "	50 "
First Class Stone and Brick	Wisconsin R. R. Commission.	75 "
Fireproof	Chicago Telephone Co.	40 "
Reinforced Concrete Building:		
Concrete Roof and Floor	Pacific Gas & Electrical Co.	50 "
Tools and Shop Machinery	Cooley	12½ "
	Starrett	14.2 "
	Milwaukee E. R. & L.	13.3 "
	Chicago U. T. Co.	20 "
	Stone & Webb	20 "

When rates are being established for depreciation on machinery, it is not often worth the trouble involved to set separate rates for each individual machine type. A fair and equitable rate on machinery as a whole would be from 7 to 10 per cent; in fact, these are approximately the rates in common use. Small tools should be written off as rapidly as possible. In some manufactories, it is the rule to write off all tools as soon as purchased, but as this method easily involves a hardship for new companies, it is well to take a lower figure, but one not less than 15 per cent a year. As changes are much more likely to be made in patterns than in tools, it is well to write off the former entirely within the space of not more than three years.

"Sinking-Fund" Formula.—It is at times considered desirable to cover the estimated amount of depreciation upon a certain property by the formation of a "sinking fund" which shall, at the expiration of the allotted time, afford an amount of money equal to the estimated depreciation. This sinking-fund method of setting aside depreciation reserves is used by many companies, but in view of the many additions and subtractions which are made to the mechanical equipment in the average plant, often considerable trouble is involved in keeping it in conformity with the changing valuations. It is used mostly by public-utility corporations where the equipment is not changed so often. To determine how much to set aside each year, in order that the desired result may be obtained, is a simple matter of calculation. The problem resolves itself into the question, "What fixed sum must I invest each year at a given rate of interest in order that, at the expiration of the stipulated time, the amount of money thus invested, together with the accrued interest, shall equal the required sum?" The following formulas show how this amount is derived:

Sinking Fund Formula:

x = fixed annual payment,
r = constant factor (ratio),
n = number of years,
V = fund accumulated after n years by investing x dollars each year at a rate r.

$$V = x + xr + xr^2 + xr^3 \text{——} xrn^2 \text{—} + xrn^1 \text{—} 1$$

This being a geometric ratio, the sum of all the terms is found by multiplying the last term by the ratio, subtracting the

first term, and dividing the remainder by the ratio, less one. This gives us

$$V = \frac{(xrn-1xr)-x}{r-1}$$

$$\text{or,} \quad V = \frac{xrn-x)}{r-1}$$

$$\text{and} \quad V = \frac{x(rn-1)}{r-1}$$

$$\text{hence} \quad x = \frac{V(r-1)}{(rn-1)}$$

Ledger Entries for Depreciation Reserves.—When making ledger entries for depreciation reserves, an account called Depreciation Reserve should be credited, and the Shop Expense Account should be debited. If this method is followed, the original

DEPRECIATION REPORT

Ledger Account	Original Value	Depreciation Reserve		Net Value of Plant	Accrued Depreciation for Current Year		Gross of Depreciation Reserve	Per Cent of Original Value
		Amount	Per Cent of Original Value		Rate	Amount		
Grounds......								
Buildings.....								
Permanent Fixtures....								
Machinery....								
Small Tools...								
Patterns......								
Shop Fixtures.								
Total Factory Plant.......								

value of the respective plant accounts will remain unchanged, except when any part may be sold or junked. In that event, manufacturing expense is debited with the loss incurred.

The accompanying form of depreciation report when filled in will show clearly just what amounts have already been set aside and how they compare in percentage with the original values.

Conclusion.—Before closing this matter of depreciation, I wish to call the attention of the reader once more to the importance of depreciation reserves from a cost standpoint. I wish also to emphasize again the possibility of advancement through collecting depreciation-experience data and, by so doing, helping to establish the ultimate standards for different classes of plant equipment. From an accounting viewpoint these points are worthy of the most careful study, with regard to both the method of creating reserves and the corresponding entries that are made as a record thereof.

CHAPTER XVI

INSURANCE, TAXES AND INTEREST

Self-Insurance.—Insurance and tax charges to manufacturing expense do not require much analysis. Insurable values are determined from an analysis of the plant accounts, deductions being made for such parts of the plant as foundations, piping, and so on, on which no insurance is considered to be warranted. In some cases, when the various risks are isolated, and when the values do not exceed a few thousand dollars in each case, some companies practise the plan of self-insurance. This plan has for its basis the assumption that when a sufficient number of such small units exist, the aggregate premiums will more than pay for any individual losses that may occur.

In this way a fund is gradually built up which will eventually become large enough to afford an income sufficient to pay the yearly expense and losses. Naturally some time is required to build up such a fund. Fires will almost certainly occur at times, and such accidents would of course have the effect of retarding the accumulation. But if the risks are carefully selected, and the proper precautions are taken against the occurrence of fires, a fund of this sort will in time grow to large proportions, and may eventually prove to be a source of dividends. One of the four

or five largest estates in New York City, whose property consists very largely of dwelling houses of the better class, has taken care of its insurance on this plan for years, and it is within my knowledge that the plan has proved highly profitable to the estate in question. Of course, the all-important part of any such plan is to utilize all possible means for avoiding any chance of large losses, and, as far as possible, by keeping the risks isolated, holding to the minimum level the losses that are bound to come.

Interest.—I have discussed the three divisions of fixed charges: namely, depreciation, insurance, and taxes, and must now attempt to answer the much mooted question, "Can interest on factory equipment be properly included as a charge to manufacturing expense?"

This is a problem well worthy the most careful consideration and analysis. A good many accountants, some of them men of high reputation, hold that interest on a factory's equipment, as represented by the plant accounts on the general ledger, should be charged to manufacturing expense, and thereby to cost of production. The gentlemen who advocate this disposition of interest charges lay themselves open to the charge of inconsistency, in that they should have gone further with the placing of their interest debit, or else should have discarded it entirely.

It is a principle of economics that a machine represents labor in a condensed form; this being so, labor and machinery are, from the standpoint of production, synonymous terms. Why, then, if we charge interest on the investment in machine equipment,

should we not also charge it on the investment in labor? We have found that a cost of production is made up of material, labor, and expense; why then should we not also charge interest on the investment used in material, or the investment in indirect expenses? To bring the discussion from the abstract to the concrete, we may suppose that a manufacturer who has three men performing certain work each day, installs a machine that does the work of these three, thus eliminating them entirely, so far as that particular job is concerned. Now labor is no longer charged against the job, but instead of it depreciation and the cost of upkeep are charged.

I have yet to find any one to whom this aspect of the problem has been presented, who could satisfactorily answer this question relative to the inconsistency in differentiating between machines on the one hand and manual labor on the other. Why some accountants, who believe it justifiable to charge interest on the investment in the machine to the exclusion of that in labor, cannot see this analogy, is something unexplainable.

My contention is that "interest" has no direct part in the cost of manufacture, but that rather it is chargeable to "profit and loss" as a direct financial expense. There is room for discussion pro and con as to the justice of charging interest, when it is based on ALL working capital, to manufacturing rather than to financial expense, but there is absolutely no justification for including interest on only the investment in the plant, and excluding interest on other working capital, such as that employed in labor, etc.

A man goes into a manufacturing business because he thinks he can make more interest (profit) on his investment than if he put his money in a bank. The profit that he adds to his cost of production is therefore in lieu of interest. By including interest in his manufacturing cost, and again in his profit, he is therefore only befogging the issue.

The Manufacturing Organization.—The shop part of a manufacturing organization should at no time show a profit. In fact, it cannot show a profit, provided all the money invested in the equipment, material, labor, and operating expenses, has been applied to these purposes. It is the function of the shop organization to turn out the best grade of goods in the shortest possible time, and with the least possible expenditure of the company's funds. This, then, being the case, the profit-making phase of the business is left entirely in the hands of the financial and selling organization, and the shop has nothing to do with whether a profit is made or a loss sustained on the goods that it has produced. This being granted, let us assume that a partition separates the two organizations, and that the money required for manufacturing is passed by the financial end of the business through a window to the shop as it is required. In such a case, the organization spending the money is not interested as to how the goods are manufactured—whether by hand labor or machinery—but simply in getting the goods called for in the shortest possible time and at the least possible outlay of money.

Now looking behind the partition into the shop

proper, we find first that these goods are all being produced by hand, without the use of any machinery whatever. Then in such a case, those accountants who advocate the inclusion of interest only on the plant equipment itself, would make no charge for interest as a part of the cost of production. A short time after this, however, the superintendent of the shop, after carefully drawing comparisons between hand labor and mechanical production, decides to install certain automatic labor-saving machines which will enable him to get rid of at least 75 per cent of the men employed under the old manufacturing methods. This machinery is introduced, and when the cost of production is figured, the shop accountant would include the interest on the investment in this new mechanical equipment at, say, six per cent of its face value. He would also charge to the cost of production the repairs and upkeep of the machines, together with a predetermined amount for depreciation.

Let us assume that the machines have been estimated to have a life of five years, and that 20 per cent of their cost will be included as part of the cost of production each year. Then, by the end of the five years, when the machines were ready to be junked and replaced by new equipment purchased from the depreciation reserve fund, the shop would be in exactly the same position it was in five years before, from an equipment standpoint, but would have in addition the interest at six per cent a year which had been set aside during the preceding five years. In other words, the shop would have this amount of money which it could not do anything with, except

to declare a dividend to itself. But we have found that the shop is entitled to no profit—therefore this money would have to be turned over to the financial end of the business.

The Sales and Financial Organization.—Now, looking at this question from the financial and sales viewpoint, we find that after the manufactured product has been received from the shop and is ready to be placed on the market, the selling price is determined by adding a certain percentage thereto, to cover selling expense and profit. Therefore, assuming that the company has disposed of all the goods manufactured by the shop durinig these five years, and that it has derived from the sale of those goods a return commensurate with the percentage of profit which it figures it is entitled to, it would then have secured a profit from two sources, viz., the producing and the distributing end of the business.

An analysis of the sales of the company for the past five years may possibly show that the sales end of the business could have disposed of considerably more goods if it had been in a position to quote a lower price than that established by the financial department. It may also show that if the shop had not included interest on its equipment in its manufacturing costs, the selling price could have been reduced somewhat below that of the company's keenest competitors. In other words, because of the fact that the shop did include interest, the company's volume of sales was considerably below what it would have been if this interest had not been included in two places in making up the selling price.

It will therefore be seen in this hypothetical case, which has its true parallel in actual manufacturiing work, that the shop might possibly have been considerably enlarged, with a corresponding increase in production to take care of the increased sales, if the lower prices had been quoted, and that in all probability the company would have made considerably more money by virtue of this excess amount of sales over what it produced, because of the greater amount of profit derived from the sales. Of course, if this profit did not exceed the amount of interest that it derived from the shop, no material benefit could be shown; but on the other hand, with a lower market price for its goods than that of its competitors, the company would undoubtedly have increased the sales in so much greater proportion that an additional profit, considerably in excess of the amount of interest received from the shop, would have accrued therefrom.

Careful Analysis Essential.—I have endeavored to present this aspect of the interest question in order to bring out, first and foremost, the fact that at no time should the shop end of a manufacturing business show a profit, and consequently that since this principle—which is a recognized axiom among all cost engineers—holds good, then the fallacy of including interest on the investment in mechanical equipment and even on labor and material, will be readily seen.

It is mainly because of the fact that accountants do not thoroughly understand the various cost-accounting fundamentals that misconceptions exist as to this

question of interest. It is, however, of such vital importance that the utmost consideration should be given to an analysis of the subject from all possible angles, in order to establish once and for all the true basis of cost-determination.

If, of two manufacturers who produced the same line of goods, one were to base his selling prices on the basis of including interest in two places, and the other only on his profit—and if they both figured the same percentage of profit above their shop cost and, with the exception of the interest charge, produced the goods at the same cost—it will easily be seen who would get the business. The manufacturer who included the interest twice could not hope to secure orders in the face of competition which under-cut his selling price. And yet, with the exception of this one phase of accounting procedure, these two manufacturers conducted business in the same way.

This discussion, then, shows the effect which an error in accounting procedure would result in, even when such parallel conditions as these existed. The importance of having manufacturers engaged in the same line of business adopt a uniform cost basis is therefore also obvious. Such a basis was needed even by the manufacturer in this case who was able to undersell his competitor. The necessity was due to the fact that without competition he would undoubtedly shortly have been getting into a rut himself; and since, as has been stated by some sage, the only difference between a rut and a grave is the depth, his existence as a manufacturer would depend on how quickly he could get hold of a good doctor.

A manufacturer often feels that he has a cost system if he is keeping track of the time of his men on jobs and figuring accurately the amount of material used. The fallacy of this reasoning is so self-evident to any one who has made even a superficial study of the question of cost-accounting, that it should need no special reference. The fact remains, however, as I have mentioned in an earlier chapter of this book, that the Federal Trade Commission reports that only ten per cent of the 300,000 manufacturers in the country have adequate cost systems.

Manufacturers' Cost Convention.—The following quotation is from a report made by the cost committee of the Manufacturers' Association at one of its conventions:

> It is admitted that the expense of installing a cost system sometimes seems exorbitant, but almost universally it is a paying proposition much exceeding in value the method too frequently employed of putting the detailed matter in the hands of earnest, but inexperienced, clerks. The building of the cost system is as much a proposition demanding education and experience as the manufacture of our goods.

A Fixed Policy Necessary.—In the segregation of fixed charges, it is not necessary to employ any complicated accounting system, but it is essential that a fixed policy be established. We have seen that these charges for depreciation, insurance, and taxes form a considerable portion of the manufacturinig expense which must be distributed to costs of production. Hence it is extremely essential that no method which so intimately affects costs should be adopted except after a most careful analysis, made in the light of a

knowledge of the future as well as with a view to the present policy of the company.

As soon as the fixed charges have been summarized for any period, transfers must be made to the several divisions of expense, on the basis of face valuations, which were discussed under the head of depreciation. These transfers are similar to the Service Charge Transfers made from former expense divisions. In this way, these charges are finally incorporated in the cost of power, rent, tool expense, and so on, and then, through the distribution of these divisions of "overhead," finally get into the shop cost summary.

CHAPTER XVII

TOOL AND SPECIAL INVESTIGATION EXPENSE

Tool Expense.—Probably the most used account in the entire group of shop expense sub-contracts, is that having to do with the maintenance and upkeep of the mechanical tool equipment of the factory. This account is called Tool Expense. It is charged with: all changes and repairs made in connection with this equipment; the salaries of clerks in the tool stock rooms, of tool-inspectors, of machine-oilers, and of men setting up machines for new work; belting used to replace that which is worn out; supplies such as oil, waste, belt dressing, and so on; and all depreciation, insurance, and taxes on the tool equipment. These latter charges are transferred from the depreciation, insurance, and taxes sub-accounts, the same as service charges, and, as explained heretofore, are assessed to each department on the basis of the face values of the equipment contained in each.

The following is a list of items properly chargeable to Tool Expense, made up in the form of a classification reference list:

Acct.	20	Sub-Class.		301—Belting for machines
"	"	"	"	302—Changes to small tools
"	"	"	"	303—Changes to machinery

Acct. 20 Sub-Class.	304—Depreciation on machy., tools, & shop fixtures (transferred from Fixed Charges)
" " " "	305—Insurance
" " " "	306—Taxes
" " " "	307—Repairs to machinery
" " " "	308—Repairs to tools
" " " "	309—Repairs to patterns
" " " "	310—Salaries—Clerks in tool stock rooms
" " " "	311—Salaries—Tool-inspectors
" " " "	312—Salaries—Machine-oilers
" " " "	313—Salaries—Men setting up machines for operators
" " " "	314—Stationery
" " " "	315—Supplies (oils, waste, lubricants, etc.)
" " " "	316—Water (other than for power or rent expense)
" " " "	317—Service charges (Brought forward from administration, power, rent, etc.)
" " " "	318—Transfers to other accounts

Plant and Expense, Orders.—In order, however, to distinguish between work which is of an expense nature and that which adds to the value of the plant equipment, it is necesary to have the orders for such work marked in some way so that the repair jobs can be distinguished from the others. For example, a tool-maker may be engaged in making new tools half a day and repairing old tools the other half. In such a case, the cost of the new tools would be charged to the Tools Account, which is one of the

plant accounts, and the repair work would be charged to Shop Expense, under the sub-classification of Tool Expense. It is therefore of paramount importance to differentiate between these two classes of work, as an error in charging the expenditure to Tools Account instead of Tool Expense would result in an inflation of the plant assets.

This mistake can be safeguarded against by issuing what are called Plant, or Expense, Orders for either new plant equipment or repair work, as the case may be, and denoting each kind of work by a special letter, prefixed before the order number. For example, all orders for merchandise to be manufactured could be called "S" orders, all work for additions to the plant buildings "B" orders, and all expense work "E" orders. Under this plan, these orders can be easily sorted, and charged to the proper account in each case.

Running Expense Order Numbers.—But there is a further differentiation necessary in the case of expense work. The "E" orders which I referred to in the preceding paragraph, and which are called Running-Expense Order Numbers, are used only for work which si of such a nature that it is not standard. In other words, to explain this point more fully, they refer to such orders as have to be specifically written when they are issued, such as E-2946: "Make the necessary repairs to milling machine number 5935 located in department number 205," or E-2947: "Cut opening for door in partition between the drilling and the polishing departments."

However, for such classes of expense labor as Por-

ters, Sweepers, Cleaners, Elevator Operators, and so on, who are continnually engaged in performing the same class of work, the same order number is used each time for classifying the expense incurred. For example, at the end of each week the payroll department reports that a certain amount of money has been paid, as wages, to these different classes of expense employees, and these amounts are then entered on the same cards or subsidiary ledger sheets on which entries of the previous weeks were made. Thus, A-1 would always be the order number for porters, A-2 the order for sweepers, A-3 for elevator operators, and so on. These are called Standard Expense Order Numbers to differentiate them from the Running Expense Order Numbers as used for repair orders, which are differently worded in each case.

In the case of the plant orders, those for additions to the building proper, as we have seen, have been called "B" orders; in the same way, orders for new tools would be called "T" orders, and those for new machinery "M" orders. This system offers a very simple and logical means of distinguishing the different kinds of work for which orders are issued on the shop, and is flexible enough in its construction to permit of expansion whenever necessary. For example, if the shop does repair work on returned or damaged merchandise, and it is desired to keep the cost of this work separate from that of work on regular merchandise orders, the orders for such repair work could be designated "R" orders. In fact, the same scheme of denotation can be used for any required purpose.

Non-Productive-Expense Orders.—The "A" orders, which were used for charging the time of sweepers, porters, and so on, are called Non-Productive-Expense Orders, as differing from the "E" orders, which are called Productive-Expense Orders. The titles are derived from the fact that in the first case, the expenditure of labor does not result in directly producing anything, while in the second case, something has actually been produced, even if only in the form of a repair that brings the tool or other equipment up to a service standard. The following is a list of such non-productive expense classes of labor as is found in the average plant:

A- 1	Elevator operators
A- 2	Disposing of rubbish
A- 3	Raw-material stock-keepers
A- 4	Worked-material stock-keepers
A- 5	Watchmen
A- 6	Tool-inspectors
A- 7	Raw-material inspectors
A- 8	Worked-material inspectors
A- 9	Finished-material inspectors
A-10	Counters
A-11	Foremen and assistants
A-12	Porters on raw material
A-13	Porters on worked material
A-14	Porters on finished material
A-15	Setting up machinery, etc.

Classifying the Orders.—After the cost of work done on these orders has been figured, and posted on the cost summary sheets, the orders are then class-

ified to Administration, Power, Tool Expense, and so on, as the work done warrants, and in exactly the same way as bills for this work would be classified if the work were done by parties outside the shop. That is, the account number is first posted on the order, and then the subclassification number, such as would be illustrated by 20-308, in which 20 would be the account number (Shop Expense) and 308 the sub-class. Reference to the Tool Expense classification reference list outlined in the earlier pages of this chapter will show that 308 refers to Repairs to Tools.

Control of Supplies.—In the average factory, large quantities of inflammable materials such as benzine, kerosene, alcohol, and lacquer are continually being used; it is important that specific instructions be issued regarding the handling and use of such materials. A list should be drawn up of those departments that have authority to use liquids of an inflammable nature. Furthermore, the maximum quantity that each department may draw each day should be specified, and the store-room keeper should be notified in order that no department may draw more than its allowance.

The use of inflammable liquids in any departments other than those so authorized, should be prohibited. If a foreman finds that his daily quantity is inadequate, he should bring the matter to the attention of the general foreman or the shop superintendent, as the case may be, in order to secure authorization for an excess supply. No liquids should be dispensed without the authority represented by properly signed stores requisition slips, and indiscriminate tapping of

barrels, tanks, and so on, should be absolutely forbidden.

I refer specifically to this question of the use of inflammable liquids first and foremost for the reason that it involves a hazard over which a proper control should be exercised at all times, and secondly because, from a cost-accounting standpoint, it often makes necessary adjustments for leakage, unaccounted for losses in volume, due to carelessness in dispensing, and loss through evaporation. All these factors will cause variations between the balance of such liquids on hand at any time, as shown by the stock records, and the actual balance on hand that would be reflected by a physical inventory. Therefore, whenever it is possible to avoid such adjustments, it is always good policy to do so.

Specimen Instruction Order.—The following is a specimen set of instructions issued by a manufacturing organization to cover the use of benzine; it will give a fairly comprehensive idea of the importance that such a plant attaches to this point.

BENZINE.

1. The method of issuing and handling benzine in this building, and the receptacles which have been procured for this purpose, are in conformity with regulations which have been prescribed by the New York Board of Fire Underwriters, and their absolute maintenance is necessary in order that the various insurance policies which have been issued, based upon the inspection of the New York Board, may not be vitiated.

2. It is essential that all foremen and their employees fully understand that all rules made in connection with the handling of benzine must be rigorously adhered to. In order that you may fully understand what these regulations are, they are given below:—

3. Benzine shall be drawn only in the two forms of approved benzine cans, known as the "reservoir can" and the "safety-spout can."

4. The reservoir can consists of an entirely closed lower chamber, connected with an upper reservoir by a pump for raising the benzine from the lower to the upper compartment, and a valve, operated by a wire, for allowing the benzine to run from the upper to the lower compartment. The upper compartment is provided with a hinged cover, which must be closed whenever possible.

5. The safety-spout can consists of a copper reservoir, fitted with a spout and handle, the handle being provided with a grip which operates the valve in the top of the can for admission of air and for refilling, as well as a valve in the spout for allowing the benzine to be poured from the can.

6. Under no conditions shall more than one quarter of a pint of benzine be removed from the approved cans to other receptacles, even for the purpose of transferring benzine from one approved can to another, and the foremen of departments using benzine must assure themselves that no reservoir can shall contain benzine in excess of the capacity of the lower compartment.

7. Benzine must not be allowed to stand in the upper compartment of the reservoir can, except when the can is in actual use.

8. Benzine must not be used in closer proximity to a gas flame than fifty (50) feet.

9. To prevent confusion and delay in the carrying out of the above regulations, due to parts of cans becoming broken, the repair of either of the forms of safety cans, where necessary, shall be carried out as follows:

a. If the can is found to be out of order, the department using it shall send it to Store 210 at once, when they will receive a spare can to use while the one returned is being repaired.

b. Store 210 will immediately send the can which is to be repaired to the millwright department, or to the tinsmith, depending upon the nature of the repair.

c. The millwright department, or tinsmith, will make the necessary repairs immediately, and will then return the can to Store 210.

d. When Store 210 receives the repaired can, it will be their duty to refill it, send it to the department to which it belongs, and receive in return the spare can which is being used by that department.

"Authorization for Drawing Inflammable Fluids." —The following Storeroom Reference Sheet shows the method of indicating those departments which have authority to draw requisitions for inflammable liquids. The cross opposite the name of each department denotes that the department indicated is entitled to the material specified at the head of the column in which the cross appears.

Dept. No.	Department Name	Shell-ac	Varn-ish	Turp-entine	Lac-quer	Kero-sene
101	Milling	..	..	×	..	..
102	Drilling	..	..	..	..	×
103	Punch Press	..	..	..	..	×
104	Lathe	..	..	..	..	×
105	Screw Machine	×	..	..	..	..
106	Grinding	..	..	..	..	×
107	Tool-Making	×	..	×	..	×
108	Cabinet-Making	..	×	..	..	..
109	Japanning	×	×	×	..	..
110	Lacquering	..	..	×	..	..
111	Power Plant	..	..	..	..	×
112	Polishing and Buffing	..	..	..	..	×
113	Tapping	..	..	×	..	..
114	Maintenance	×	×	×	..	×
115	Assembly	×	×	..	..	×
116	Millwright	×	×	..	..	×
117	Repair	×	×	×	..	×
118	House Carpenter	×	×	..	..	..
119	Plating and Dipping	..	..	..	..	..
120	Laboratory	×	×	..	..	×

Shop-Order Authorizations.—Owing to the fact that accuracy in cost accounting depends to a great extent on the proper classification of all work done by the factory, and in view of the fact that the orders issued to the foremen are of different classes, such as the running-expense orders, plant orders, and merchandise orders referred to in the beginning of this chapter, it is very important that no work be begun without proper authorization.

For example, in a well-organized factory the regular merchandise orders would be issued by the shop-order department, the orders for repairs by the maintenance department, and those for new tools, patterns, and so on, by the mechanical department. In case work is resumed on a running-expense order after such work has once been discontinued, it is always good policy to have a new order issued before again proceeding with such repair work or other expense work. A list of persons authorized to issue each class of orders should be given to the foremen in charge of the various departments of the shop, so that no work may be done except on proper authorization.

Condition of Gauges.—Foremen should be held responsible for gauges damaged while in their departments, and also for using them when it is clearly evident, or may be readily determined (as in the case of micrometer calipers), that they are in an unsatisfactory condition. Foremen should arrange to have their gauges checked with their gauge files when the annual inventory is made, to insure that they have a record of each gauge. All exceptions should be immediately reported.

Investigation Expense.—It is often necessary to carry on a systematic series of investigations of matters pertaining to manufacturing, in order to improve the quality of the output of the factory, or to reduce the expense incidental thereto. Such investigations may or may not be properly classified under the head of shop expense. The account charged in each case depends upon the nature of the work—that is, whether it is solely for the benefit of the shop, or whether it is of a general company nature.

The purpose of a systematic routine of handling such investigation cases is to provide a complete record, properly arranged for future reference, of each phase of the studies made; to promote means for incorporating in the records each question when it arises, and for following it up thereafter. Such an arrangement is a guarantee that no matters will be lost track of, and that each will receive adequate and prompt attention.

Classes of Investigations.—These investigation cases can usually be divided into five groups, as follows:

Group (a) Shop Superintendent's Cases.
" (b) Clerical and Routing "
" (c) Manufacturing "
" (d) Inspection "
" (e) Service & Maintenance "

When investigations are to be made in connection with any case confined to a particular branch or department of the shop organization, the case should be

entered in, and assigned a number from, the series of investigation cases of the branch affected.

Method of Assigning Case Numbers.—When it is necessary to have more than one branch do work on any case, the case should be assigned a number in the series of Shop Superintendent's Cases. In instances when an investigation is started and numbered in one branch, and is then taken up by another branch, the number should be changed to one in the series of Shop Superintendent's Cases.

The shop branches mentioned in the preceding paragraphs refer to those similar to the Machine Branch, Assembly Branch, Finishing Branch, and so on, which are found in organizations of metal-working plants, and in other industries where the shop organization is subdivided according to branches, to denote different phases of work.

Origin of Investigation Cases.—Special investigations can be requested by any organization unit, but should not be made without the approval of the head of the particular branch concerned. These branch heads, however, can usually order such investigations without further approvals, provided the making of the investigation and the cost incidental thereto do not affect any other branch of the factory. The shop superintendent has authority to order an investigation in any series, but when it will affect more than one banch, it is charged to his series of orders.

Procedure of Making Investigations.—The plan of procedure in making such special investigations is usually as follows:

(a) As soon as a question arises which promises to involve some study, and which seems to be of importance, an outline is prepared showing the "Purpose" of the study which is contemplated, and the "Method" of doing it. The following is an example of the method of presenting a case recommended for special study. It is taken from a set of instructions issued by a large manufacturing company—of which some of the foregoing paragraphs form a part—as a guide to its organization units in matters calling for special studies of this kind.

(1) Study the character of work and internal organization of each department, in order to determine the several conditions that affect proportions of "Productive" and "Expense" Hours. Care must be taken to discriminate properly in the use of the following terms:

Productive Merchandise Hours

Productive Expense Hours

Non-Productive (Expense) Hours

(2) Classify the various departments on the basis of results found, putting those together which have the same proportion.

(3) From records, get past variations in the ratio of Expense or the different classes of Expense and Productive Hours, with such explanations as can be found for extremes.

(4) Analyze the data and prepare curves for each department and group of departments, and for all "Manufacturing" departments combined, showing what the ratio should be under normal conditions.

(b) Investigation cases of this kind and of similar kinds should be opened only when the expense that will be incurred is warranted by the possible results.

On receipt of orders to proceed with such a case, a number in the proper series should be assigned to the order and should be cross-indexed on cards, in order that both the order number and the description of the work being done may be easily referred to. From the time the work is started until it is entirely completed, a full record should be kept of all work done on each order, and also of all data collected, all correspondence, and so on. All papers pertaining to each case should be kept in a separate numbered folder or envelope, and these should be filed in some logical sequence that will make them easy of reference.

(c) At periodic intervals a brief report should be prepared for each case being investigated, on which should be shown the results, if any, accomplished up to that time, and the procedure of work which will be followed in the immediate future. If any new cases have been entered during the preceding period, they should also be included, even if no work has as yet been done on them. It is important that each periodic report list every case, even if no other mention is made than that it is "Not Started."

Numbering Investigation Cases.—In order to make possible an easy way of differentiating between investigation cases being handled by the different branches of the factory, order numbers are allotted in blocks of 100,000 or 10,000 to each branch. These numbers, then, on an order immediately designate the particular branch of the factory organization engaged in making the investigation. For example, the Manufacturing Branch may be assigned numbers

from 1 to 9999, the Inspection Branch numbers from 10,000 to 19,999, and so on. The Manufacturing Branch could then, for instance, reassign certain blocks of its allotments of numbers to the various departments comprising the Manufacturing Branch. Thus each department of every branch would eventually have its own specific block of order numbers, by means of which it would be comparatively easy to trace any order.

Method of Filing Investigation Cases.—(a) Papers should be filed in each department in folders or envelopes by case numbers. The case number and the subject of the case should be written on the outside of the folder or envelope, together with the number of the department in which the folder is filed. Papers should, as a rule, be kept in chronological order; the later papers should be on top, and additional papers should be added from bottom to top as the work progresses. If the development of the case tends toward two or more distinct divisions or subsidiary subjects, the correspondence on each division should be separated, so far as possible, and the papers of each division should be kept together. A list of all papers should be kept in front of each folder. In cases in which a subject has been subdivided, a list should be kept in front of each division, and the main list should show the name of the division. If verbal arrangements are made, or information is obtained or given verbally, a note should be inserted in the record of the case, in order that such data may not be lost sight of.

(b) The detail papers should be kept in the depart-

ments in which the information was prepared, except when required by a superior for his file. The records in the shop superintendent's file, and those of the heads of the branches, should, as a rule, contain only the main papers on the cases, and should not be burdened with details that ought to be kept in the departmental files.

(c) As a rule, the folders or envelopes should be either filed vertically or kept in a place reserved for them in a drawer of the desk. The details that they contain should be kept at least one year after the case is closed, and then should be destroyed only on the approval of the head of the branch.

(d) When a case is closed, the file must contain a complete résumé in the case folder, outlining briefly all of the main facts brought out by the investigation, as well as the conclusions reached. The papers must then be arranged in what seems to be the best and most logical sequence, and, after the indexing has been checked and made as complete as necessary, they should then be filed as before.

(e) Progress reports on investigation cases should be filed by report numbers except when the report covers one specific case. Reports on specific cases should be filed in the folder with those cases. Shorthand books must be filed according to dates. Progress reports and shorthand books should be kept at least three months.

Records of Investigation Cases.—Besides the file of folders and envelopes a list should be kept by case numbers, in order that each may be continually before the attention of the person who is working on it. If

the volume of work becomes sufficient to warrant, an alphabetical file should be started, in order that reference may be readily made to all cases and to all important parts of any particular case.

The person in charge of each main file must keep complete records, both numerical and alphabetical, must see that the periodical report is received from every department assigned to work on the case, and must be held responsible for keeping the summary of reports on each case up to date by transferring entries from the department reports as soon as the latter are received.

Specifications for Shop Work.—In issuing specifications covering orders to be worked on by the shop, it is always good practice to issue them in some kind of sequence. As a rule, all the information needed by the shop is of one of the following two classes: that of a general nature, such as could be stated in specifications covering certain groups of orders or classes of merchandise; or that which is of a specific nature in each case, and which would require drawings. Such specifications would usually cover raw material, repairs, finishes, and processes of manufacture.

Use of "Sample-Finish Cabinets."—Some factories have adopted what are known as sample cabinets, in which are contained samples of all kinds of finishes used on their particular class of output. These cabinets are continually kept up to date by the inclusion of additions and changes as they are adopted by the management. Each department that has occasion to compare finishes with the standards adopted by the

company, is furnished with one of the sample cabinets. Thus specifications as to finish can be referred to by number, grade, and so on, and accordingly can be easily interpreted.

"Outside-Limit" Material.—It often happens that material, whether raw stock, goods in process of manufacture, or finished goods, cannot be used for the purpose originally intended, because it is either just under, or just over, the maximum limit of variation allowable. It does not necessarily follow, however, that this material has to be junked. Some means may be found whereby it can be used in another department, or on another class of merchandise, where such variations will not constitute an impairment of its service value. Whether the material can be so used, or whether no alternative remains but that of sending it to the scrap heap, depends on the thoroughness of the investigations concerning the use of such "outside-limit" material.

When the inspection department considers it advisable to keep such stock separate in the storerooms, because use can be made of it on some other goods, or because of the urgent need of such specific parts, the destination ticket accompanying the material to the stock-room should be stamped "Outside Limit." If the work has been done by a piece-work operator, and if the defectives are to be paid for, the operator should receive credit on the "piece-work credit coupon" of the combination time-ticket referred to in a preceding chapter. The time-ticket from which it is detached, and which is sent to the payroll department, should be stamped "Defectives Paid For."

This designation will advise the payroll department that no deduction is to be made for such defectives; at the same time, this time-ticket will complete the chain of storeroom records, for the storeroom employees will be able to differentiate between the material marked "Outside Limit" and that which is stamped O.K.

"Outside-Limit" Material To Be Repaired.—When "outside-limit" material is delivered by a shop storeroom, the storekeeper should stamp the department record of the material requisition blank "Outside Limit." He should also give the lot number on which the material was originally worked, as well as a description of the deviation that caused its rejection for that particular order. When "outside-limit" material is to be repaired in a manufacturing department, and is afterward to go into stock as good material, the inspection department should make out a repair ticket in duplicate. One copy should be sent to the inspector who has jurisdiction over the department where the repairs will be made, and the original should be retained by the inspection department as its record. With respect to raw material, the method of handling would be exactly the same as for worked material, except that the process-inspection section of the inspection department would approve it, instead of the finished-material section of the same department, as would be the case if finished material were rejected.

Changes In Drawings Or Specifications.—It is occasionally necessary, even in the best planned manufacturing organizations, to make certain departures from

the procedure implied in the information contained in drawings or specifications of work going through the shop. This may be due to either of the following causes:

(a) Investigations in regard to processes or trial of new processes.

(b) The standard information, temporarily, may not be applicable on account of special conditions, that are peculiar to the case in hand; or in emergencies, temporary information may have to be issued in advance.

In circumstances indicated under (a), special written instructions should be issued to the foreman as their authorization for departing from the standard methods or processes originally called for by the drawings or specifications. In cases that fall under (b), the drafting department should issue these supplementary instructions in the form of drawings, or the engineering department in the form of specifications. It should be clearly understood that any information so authorized would only temporarily replace that given on the drawings or specifications, and would cover only the lot or lots of work to which reference is made in each case. Copies of any such changes, which represent departures from the procedure indicated by the drawings or specifications covering the standard line of work, should be sent to the inspection department and to the foremen in order that they may become informed of such changes.

Inspection And Repair of Scales in Shop Departments.—All scales used in manufacturing departments should be inspected at least once each month, in order to safeguard against errors in weighing and counting. Scales for counting small parts have now become so general that it is of paramount importance to see that such counting scales are properly adjusted. A mistake might not only cause considerable havoc in the scheduling of orders, but might also work an injustice to piece-work operatives, who are paid on the basis of the number of pieces turned out. Or, on the other hand, a mistake might result in an over-payment of wages to these operatives if the scales counted an excess over the actual output of such employees.

The cost of making such inspection and repairing would be charged to material expense and not to tool expense. Special inspections may also be required when scales get out of order between such regular inspection periods as I have mentioned in the preceding paragraphs. In such a case, the foreman of the department would, of course, immediately request such an inspection with a view to verifying his deductions, and issuing an order for the necessary repairs. In most cases, however, slight adjustments or repairs can be made immediately by the inspector. Orders for such repairs would be issued on the running-expense order form of the "E" series referred to in the first part of this chapter.

Shop Instructions.—From what I have already said in this chapter, it will be seen that there are many exceptions to standard manufacturing practice, in any

shop, which require special instructions governing each specific case. My purpose in citing such exceptions has been to bring forcibly to the attention of the reader the importance of issuing what are called Shop Instructions to cover such cases. The method of handling inflammable materials, the use of running-expense and plant orders, the method of making special investigations, the routine for handling "outside limit" material, and so on—all of which have been discussed in this chapter—are instances in which special instructions have to be issued to cover each case. This matter of instructions can best be managed by starting in each department a Shop Instruction Book, in which can be filed from time to time—as they are issued—instructions covering any exceptions to the ordinary shop routine, or even those covering such of the regular routine in connection with which there may be any doubt as to the method of procedure on the part of the departmental foremen or their clerks. In large manufacturing plants, these instructions are multigraphed and numbered in cardinal sequence, and a copy of each set of instructions is sent to every foreman, irrespective of whether or not he may be immediately concerned with the particular purpose in mind at that time. When these are received by the foremen's clerks, they are then filed in the clerk's instruction-book binder, the title of the instructions is entered in the front part of the book on an index sheet. The "instruction number" is posted alongside such descriptions, so that it serves as a page index.

While not all the points covered in this chapter

pertain to tool expense—as in the case of inspection of scales—I have treated them at this time mainly for the reason that all the expenses of making any such inspections or investigations as have been shown, are often indiscriminately classified as Tool Expense, mainly because they have been incurred in the factory. It will therefore be important to note these distinctions, and make sure of their relation to whatever division of shop expense they may be applicable to.

CHAPTER XVIII

MATERIAL EXPENSE, WASTE, AND IDLE LABOR

Material Expense.—Material expense may be defined as all that expense which is incurred in the purchasing, receiving, inspecting, handling, and storing of all shop materials, raw and worked. It consists of two main subdivisions, namely: raw- and worked-material expense respectively. It includes in part such expenses as salaries of stock-keepers, porters and freight-elevator operators, and all fixed charges, such as depreciation, and insurance and taxes on the materials, fixtures, and so on, used in connection therewith. It includes, also, the service charges transferred from other divisions of shop expense, for power, light, heat, and floor space, and the administration expense incurred in connection with material.

For the sake of simplicity, and to aid the detection of excess expenditures or forms of waste, it is advisable to classify material-expense charges to either Raw-or-Worked-Material Expense, rather than to one general set of classifications called Material Expense. The same method of classifying charges as heretofore explained under Tool Expense and other divisions of the Shop Expense Account is followed;

namely that of posting first the account number, and then the sub-class. The following is a specimen classification reference list covering items properly chargeable to either of the two divisions of material expense:

RAW-MATERIAL EXPENSE

CLASSIFICATION REFERENCE LIST

401—Changes to patterns and to shop fixtures in raw-material stock-rooms
402—Changes to permanent fixtures, pertaining to material
403—Depreciation on raw material, fixtures, etc.
404—Changes
405—Insurance on raw material, fixtures, etc.
406—Taxes on raw material, fixtures, etc.
407—Repairs
408—Salaries, clerks on raw material
409—Salaries, receiving department
410—Salaries, inspectors of raw material
411—Salaries, raw-material stock-keepers
412—Salaries, freight-elevator operators (part)
413—Salaries, raw-material porters
414—Stationery
415—Unclassified raw-material expense
416—Testing expense (including laboratory work, etc.)
417—Service charges (Brought forward from administration, power, rent, etc.)

WORKED-MATERIAL EXPENSE

451—Changes to Shop fixtures in worked- and finished-material stock-rooms
452—Changes to permanent fixtures, worked material, etc.
453—Depreciation on permanent fixtures, worked material, etc.
454—Insurance on investment in process material and on fixtures

455—Taxes on investment in process material and on fixtures
456—Railway expense (where sidings, etc., are used)
457—Repairs to shop fixtures in worked- and finished-material stock-rooms
458—Wasted material
459—Repairs to shop and permanent fixtures in worked- and finished-material stock-rooms
460—Salaries, clerks on worked- and finished-material stock records
461—Salaries, stock-keepers
462—Salaries, porters on worked and finished material
463—Salaries, cranemen
464—Salaries, counters
465—Salaries, inspectors of worked and finished material
466—Salaries, freight-elevator operators (part of total chargeable to worked material)
467—Stationery
468—Unclassified worked-material expense
469—Wrapping paper, cartons, boxes, etc.
470—Service charges (Brought forward from administration, power, rent, etc.)

From the above classification list of raw- and worked-material expense, it will be seen that this division of shop expense is composed of quite a large variety of expense charges. The practice at present in vogue in most manufacturing plants is to consider all material that is wasted in cutting, spoilage, or shrinkage, as just so much unavoidable scrap, and to take interest simply in the question of how much revenue it is possible to derive from disposing of it to junk dealers, or through other mediums. My opinion has always been that this method of treating waste material—whether controllable or not—as simply a scrap item, and of charging with this

entire cost the cost of any order on which the material has been used, is wrong. My contention is based on the fact that it offers entirely too easy a means for the management of the shop to cover up its own mistakes.

Waste in Cutting Sheet Stock.—Take, for example, just a very simple illustration. We shall say that out of a sheet of metal of a certain size, ten pieces of irregular shape could be punched if the punch-press operator were properly instructed as to how to get this maximum quantity out of each piece. But the operator, without proper instruction, succeeds in getting only eight pieces punched, and the resulting waste in the sheet stock is equivalent to at least two additional punched pieces. Now in such a case, under the present method of treating this question of cost of material, the eight pieces that the operator punched would cost as much as the ten pieces would cost had some forethought been applied, and the waste stock is sent to the scrap room and disposed of at a price considerably below what it originally cost the company. The question, therefore, to be answered is: Should the management in this case be permitted to cover its own inefficient administration of the shop by charging the entire cost of the good and wasted sheet stock as part of the material cost of the order?

Waste Absorbed as Part of Entire Shop Production-Cost.—In order that there may be no misunderstanding concerning the point that I wish to bring out here, it should be thoroughly understood that there is no way in which this waste can be eventually

eliminated as a part of the cost of the entire production of the shop in any given period. On the other hand, the real crux of this particular situation is the question as to the exact element of the final cost into which this waste should be charged.

We have seen from preceding chapters that a shop cost is made up of three distinct elements, viz., Productive-Labor, Raw-Material and Shop Expense. We cannot charge this waste into the Productive Labor division, and therefore, if we dispute the present method of charging it as a part of the material cost, there remains only one division in which to finally dispose of it, and that is Shop Expense. Therefore, Material Expense as a subdivision of Shop Expense, would be the logical place to charge such waste, provided we can prove conclusively that it should not appear in the raw-material cost.

The reader may question the reason for laying so much emphasis on what, at first thought, may appear to be a rather far-fetched differentiation, and he may say, "What difference does it make where I charge it, so long as it finally gets into the completed cost?" The answer to this question can be supplied by stating that excesses in the amount of shop expense incurred for any volume of output will be easily reflected by either increases in the rate of this expense per labor hour, or by an increase in the percentage of expense as based on the productive labor for such a period; while, on the other hand, an excess in the material cost could not, in the first place, be so easily detected, especially if the same error had been made constantly for a period of months or years. Further-

more, the shop expense is subject to analysis according to its various subdivisions, as I have explained in the preceding chapters. These subdivisions would show the relative expenditures for administration, power, rent, material expense, and so on, and through the further analysis made possible by the sub-classifications of each of these divisions, abnormal charges could be easily detected. But in the case of the raw material used, such an analysis would involve an exhaustive study of each and every class of goods manufactured. It will therefore be evident that, if for no other reason than that one of two alternatives offers a better means of executive control than the other, that means should be the one used as a basis of establishing such a control.

Shrinkage in Brass Foundries.—Still another example of this possibility of governing needless waste is found in the case of shrinkage in brass foundries. In one case that came within my own experience, there was a shrinkage of more than 8 per cent in the amount of metal that was sent to the foundry to be turned out. This, compared with a normal shrinkage of from 1½ to 2 per cent, made a maximum variation of over 6 per cent in excess of the allowable shrinkage. The plant in question poured about 8,000,000 pounds of metal each year, and therefore the reader—if he will take the time to compute the shrinkage of 6 per cent on this pour of metal, and figure the cost of brass at approximately 20 cents a pound—will see that the item in question was well worth the cost of any means by which it could be detected. This illustration again brings out the point

that the management was able to conceal this loss, whether intentionally or not, because no way was provided of showing it up, except that of special reports which would show the difference between the amount of metal delivered to the foundry and that received from it.

In this particular case, such a comparison was never made; but if a sub-classification under Material Expense had been in use, and had offered a means of charging this shrinkage each month—assuming that this charge had been made—it would have immediately been called to the attention of the management. This illustration is used not so much to bring out the weakness in the report system of the company, but to show that the present method of charging the entire cost of all the material sent to the foundry against the output of that foundry, made possible the overlooking of this very considerable factor of waste which was involved in the form of shrinkage.

The Remedy—Executive Analysis of Shop Expense.—The remedy for this state of affairs lies in the exercise of adequate executive control through the analysis of shop expense and in providing standards that the workmen can follow. This does not necessarily mean that a simple and easy solution of the problem is offered, for undoubtedly just the opposite will be true in most plants. In order that the management may know exactly what are the maximum number of pieces of any special design which can be cut out of any size of sheet stock, it is necessary for them to have such investigations made as

will result in the fixing of adequate standards in each case. The proper solution seems to be to have the planning department specify these standards for each order as it is issued on the factory. Then the rest becomes simply a matter of checking up the extent to which the workman has followed these instructions.

Under the present arrangement, however, the planning departments of even the best-managed factories overlook this phase, and simply issue instructions on the shop concerning the amount of time allowed for each order, the machines on which the work is to be done, and so on. Moreover, they pay no attention whatever to the problem of setting a standard to be followed by the workman in each case. According to the present system, if a workman has used up all the sheet stock that he has been permitted to draw from the store-room on requisition, and still finds that he has a certain number of additional parts to turn out, his request for more material will invariably be immediately approved by the foreman of his department, and a further requisition will be drawn on the store-room. These requisitions then, in turn, become a basis for figuring the material cost of the job, and not the least attention is paid to the factor of waste involved. Under the arrangement herein advocated, a small beginning could be gradually developed into a very adequate control of the entire plant, by charging such difference between the actual output and the established standard, to Material Expense under the classification of "Waste Material."

The length of the period necessary for the establishment of such control over the entire plant will depend, of course, on the particular class of manufacturing that is being done, as well as upon the size of the plant in question. A starting point can, however, be made in the average plant at almost any stage of production, and progress may be made to the point where the desired standard is attained.

Utilizing By-Products.—We have been considering in the preceding paragraphs the general question of wasted material, but there is also to be considered the question of waste which cannot be eliminated, and of waste material which, according to its nature, can or cannot be used as a by-product of the business or for some manufacturing process other than the original one. For example, in the manufacture of ostrich feathers into plumes and fancies, when the flues are cut from the stem this stem becomes useless in the plume department. It is then transferred to the fancy feather department and is used there as raw material.

In shirtwaist factories, pieces that have formerly been thrown away are now used in making small flags. In the silk business, certain parts of the silk, which are a by-product of the raw silk, are gathered together, assorted, straightened out, and by a special process are made into what is called artificial silk. This is used especially in making silk hosiery. In a factory that manufactures rain coats, the strips that cannot be cut are made into bathing bags or caps. In a meat-packing plant, in which the hoofs, fats, hide, hair, and so on, remain after the meat itself has

been packed, this material is used for making soap and glue, and for other similar purposes. If cotton is placed in a dry room, all the moisture it contains will leave it. In other words, if no account were taken of this fact, a loss would be sustained if the cotton were sold after this evaporation had taken place. A knowledge of this fact has resulted in the adoption by the trade of a standard rule whereby cotton is bought and sold on an 8½ per cent moisture basis.

With the exception of the case of shrinkage just cited, all the instances mentioned in the preceding paragraph are examples of utilization of by-products. In New York an average of about 55,000,000 cocoanuts are opened yearly, a large percentage of which are used in the manufacture of shredded cocoanut. In the factories where this work is done, this vast number of cocoanut shells, which have a heat value per ton equal to that of one ton of coal, is a by-product that can be used by the power plant. Rancid and decayed nuts constitute a form of waste that is non-redeemable.

In citron and peel factories, where candied citron is produced, the peel is first removed from the pulp, then squeezed out and packed into tubs of syrup. After this, the citron is dried and given more baths of syrup to increase its weight. The important point in connection with this illustration is that while lemon and orange peels both undergo much the same course of treatment, the amount of spoilage is much greater in the case of the orange peels than in that of the lemon peels.

These are typical cases in which the waste is more or less beyond the control of the factory management, and they are in contrast to the case of sheet stock, previously referred to, in which the waste could have been stopped by the exercise of proper executive control. The question of whether or not the form of waste is controllable does not affect the method of reflecting it on the books of the company. If the waste is justifiable, it can be easily explained; but if, on the other hand, it is not, the records of the company should be so kept that it cannot be lost sight of. Therefore, irrespective of the cause of waste, material expense should include charges that will show the extent to which all waste has been incurred.

Classification of Waste.—Waste may be arbitrarily divided into three main classes, viz., Material Waste, Time Waste and Miscellaneous Waste. The last is more or less a combination of both material and time waste. A further subdivision can then be made in the case of material waste—namely: raw-material waste, worked-material waste, and finished-material waste.

Material Waste.—An example of raw-material waste is the shrinkage in stock-rooms; wasteful cutting of stock by the store-keepers; breakage; the scrapping of material on account of defects which were not detected by the inspection department of the factory when the material was purchased.

Worked-material waste is that commonly caused by defective workmanship. Some of the results of this kind of waste are the following: the scrapping of

the material worked on; losses sustained through forced sales of over-stock piece parts at sacrifice prices; bad castings, the defects in which are not discovered until considerable machining has been done on them; shrinkage of worked material in stock-rooms, due to theft and other causes; and such loss as might be incurred by poor workmanship produced by piece-work operatives—the work gets by on account of lax inspection methods, but later on has to be discarded.

Finished-material waste is caused by shrinkage in stock-rooms, damage to the finish of completed merchandise carried in stock, and losses sustained as a result of forced sales of "over-stock" or obsolete merchandise, for which there is no longer a market.

Time Waste.—This type of waste may be arbitrarily divided into two distinct classes—Direct Time Waste and Efficiency Waste. Under the first class would be included the time waste in the average factory that results because workmen have to wait for something to do, on account of poor routing and scheduling of orders. In this class also belongs, first, time waste due to faulty power-generating equipment, which results in the power being shut off while repairs are being made, and, secondly, that waste caused by breakdowns in the mechanical-transmission system—such waste as that incurred when line shafts or belts break.

Under the efficiency-waste division of time waste would be included the loss of time when, because of poor routing of jobs, a machine has to be set up first for one job, broken down for a different operation,

and then set up again for the first job, and so on. If the work of the factory had been properly planned, not more than one setting-up would have been necessary for each job. Under this classification would also be included such time as is wasted by workmen in reporting their time at the start and completion of each job to time clerks. In the average factory, where the job changes range anywhere from five to ten a day, and where one clerk—centrally located on each floor—takes the time on each job, each workman is required to report to this clerk at the start and completion of each job to which he is assigned, and in doing so, manages to waste considerable time during the course of the day. This waste could be eliminated by providing some means whereby the workman would not be required, in order to report, to leave his bench or machine, but could keep constantly employed on actual production.

Time Waste Due to Job Changes.—That the reader may appreciate just what this loss means in the average factory, I shall take as an example a plant where 300 operatives are employed, and where the average number of job changes amounts to 6 a day. If we assume that the workman would lose only 3 minutes in reporting each job change and getting back to his bench or machine, then in the course of a day each workman would lose 18 minutes, and the total time lost, figured for the entire force of 300 operatives, would amount to 90 hours. If we further extend the time for a period of one year of 300 working days, it amounts to 27,000 hours, and the money loss to the company, if figured at a nominal rate of 25

cents an hour, would amount to \$6,750. When we stop to consider what this will mean in a plant employing 30,000 or 40,000 people—of which there are a number scattered throughout the country—a fair idea of the importance of this form of time waste will be easily gained.

Time Waste, Poor Wage Systems, and Low Output. —Still another form of time waste which comes under this division of efficiency waste, is that due to a low output caused by poor wage systems in force. In a plant where a man is working on a straight rate per hour or day, he is simply interested in holding his job and in doing just enough work to maintain his standing with the company. The result is that, because of lack of incentive, he produces a volume of output considerably lower than would be obtained if some one or another of the "incentive-instilling" forms of wage payment were in use. In a number of manufacturing plants where I have personally made studies of this question, I have found that the average workman, when employed on a straight day-work wage rate, produces only about 60 per cent of what he would if he were paid on a piece work basis and given fair treatment. In making this statement I am not making it as a reflection on the workman, but rather "putting it up to" the management for the short-sightedness on their part. It is only human on the part of the workman to fall short of his highest efficiency if no opening is provided for him whereby, through the results of his own extra endeavors, he can share in the profit to the company resulting from increased production on

his part. It is not my intention to discuss at this point these various forms of wage payment, which have been treated thoroughly in another volume. But I do wish the reader to keep in mind the fact that where such a condition is permitted to exist, an actual waste is incurred, even if it is not directly apparent from an analysis of the charges for waste as shown by the expense account of the factory.

At the plant of the Packard Motor Car Company, where over 10,000 operatives are employed, and where seven-eighths of all the machine workers and assemblers are on a bonus or premium system, the workmen earn an extra bonus, or premium, of 25 per cent by virtue of their own special endeavors. This is just one concrete illustration of the practicability of the bonus system—many could be cited—showing the possibilities of eliminating this form of time waste.

Accounting for Utilization of By-Products.—From an accounting standpoint, it is necessary to make the proper adjustments for the utilization of by-products, as well as for waste incurred. In the case of the cocoanut shells—previously referred to—which were used as fuel, the Raw-Material Account would be credited and the Shop Expense Account debited under the sub-account, Power. The extent of the charge must necessarily be fair with respect to both sides of the transaction; power expense would be charged simply with the coal-value equivalent of the cocoanut shells that it uses for fuel. In this same way, adjustments are made wherever a by-product of one department or part of a shop organization be-

comes the raw material, fuel or supplies of another.

Charging Idle-Labor Expense.—In the same way, all labor that cannot be charged against specific production orders, plant orders, or any other of the merchandise or expense orders issued on the shop, or by the shop, itself, should be classified as Idle Labor Expense and, as such, charged to the Shop Expense Account. These charges would be also entered in the subsidiary-analysis ledger under the sub-classification of Idle Labor Expense.

An inspection of these charges in the subsidiary ledger, made from time to time, offers a simple means of arriving at the actual waste that is being incurred in the form of unemployed labor, owing to either poor routing, breakdowns, or other forms of waste traceable to inefficient management. It will here again be seen what an important part, from a management viewpoint, the subsidiary ledger plays.

Charging Material Expense.—Material expense, as explained in one of the first chapters of this volume, is assessable against the output of the factory on the basis of the bulk (or weight) of the material. For practical purposes, the basis of weight can be used in the average factory. After the normal material expense for the year has been arrived at, it should then be applied against the estimated output and should be reduced to a percentage of the weight. This percentage, when applied against the weight of material used on any order that is being figured, will give the material expense assessable against that order.

In arriving at this percentage it is important to

keep in mind the fact that certain classes of goods may, for some reason or other, incur a greater amount of expense in purchasing, receiving, handling, and storing than others. For example, the expense of handling breakable material may be sufficiently greater than that for unbreakable material in a factory using both. It would therefore be only fair to charge a larger percentage for such breakable goods because of this fact. However, this is a point that has to be considered independently in each factory—and no rule can be laid down for all cases.

The Management's Responsibility.—Idle-labor expense, in the average factory, is more or less a result of the local administration in each department. It should therefore be assessed against departments on the basis of the cost of idle labor incurred by them, and as shown in the departmental-expense analysis ledgers. Here again, however, a specific ruling cannot be laid down, since in some plants this idle labor is incurred through poor routing of orders or because of lack of such orders. These are instances in which expense is directly traceable to the general management of the factory, and therefore cannot justly be assessed against any one department. In such cases, it should not become a part of the expense loading assessable against the product of the shop as incorporated in the shop cost, but should be charged back to the general management of the company into an account called Management Expense, or into some other similar account. I shall discuss this question of the management's responsibility more fully in a later chapter.

CHAPTER XIX

ESTABLISHING THE BASIS FOR ASSESSING THE EXPENSE LOADING.

Expense Loading, and Method of Application.—In the preceding chapters, devoted to the analysis of the various divisions of shop expense, we have seen that each class of expense is assessable to production centers, according to the way in which it is incurred. Administration expense for example, was found to be assessable on the basis of employees, power expense on the basis of kilowatt hours used, rent on the basis of floor space occupied, fixed charges on the basis of face values of equipment, material expense on the basis of bulk (or weight), and tool and idle-labor expense to the extent incurred by the various production departments.

The aggregate of all these charges must be absorbed by the output of the factory during a specific period. This period is usually the fiscal year. In cost computations, this expense is called the Expense Loading when applied as a whole, or the Machine-Expense and Material-Expense Loading, respectively, when applied as two separate loadings. The method of applying the loading for expense, depends on the type of manufacturing engaged in, and the manner in which the expense charges have been classified. It would be useless in some lines of manufacturing

to assess this expense in any further detail than against the output of the plant as a whole. In other lines, a segregation by departments would be sufficiently accurate for practical purposes, while in still others the most accurate cost figures are required, and they can be obtained only through a segregation of the expense by machines.

Establishing Normal Expense Basis.—Before the shop-expense loading can be reduced to a percentage of the labor cost, a rate per hour, or any other basis of distribution, the figures must be carefully analyzed, in order that it may be determined just what would constitute a normal basis. This normal figure would in all probability be one neither high nor low as compared with the current figures being anaylzed, but would be a safe basis on which to compute costs for the ensuing year.

The accountant, as well as the average manufacturer, is often too apt to measure events in periods of a month or a year, whereas the cycle through which such experiences should actually be computed, may be at least several years. If our calendar year consisted of thirty-six months instead of twelve, the natural tendency would be to measure events in periods of what would now be equivalent to three years, and in all probability any average for one year would vary quite appreciably from one arrived at on the basis of three years' experience. Therefore, the mere fact that the ledger accounts of a manufacturing business are closed out at the end of each fiscal year, should not affect the limitations of the business as a whole, or in any part thereof.

Cycles of Activity.—This is a vital point from an expense-loading standpoint, since extreme fluctuations in any period may be due solely to current conditions, and would not, under such circumstances, constitute a safe basis if used for cost-determination purposes for the ensuing year. It is therefore important to consider these so-called fluctuations with respect to the normal trend of the company's business. Considering this question from the viewpoint of shop-expense analysis, we find many instances in which the expenses of the shop for one quarter of a year are almost double that of other quarters showing the same degree of activity. Upon analysis, however, it may be found that during this quarter the boilers in the power plant were overhauled, or changes were made in the physical layout of departments, construction of partitions, for instance—or possibly a heavy charge was made for injuries because some accident occurred during this period. In fact, numberless cases like those cited could be mentioned, all as illustrations of what might be classed as abnormal expenses for any period.

These so-called abnormal expenses must, of course, be eventually absorbed as part of the cost of the finished product. The important point to consider, however, has to do with what this period should be, whether a year, two years, or longer. Some cycle has to be established. It can be done in only one way, and that is by analyzing the experiences of the shop for a number of years back, making use of the knowledge of conditions as they appear at the time the study is made, and supplementing both past and

present data with an estimate of probabilities for the ensuing years, in so far as estimates of this nature—in regard to the future—can be made with any reasonable degree of accuracy.

Cost-determination methods which in all other ways are based on standard practice, and which have been worked out with extreme care, often fail to produce the desired results, simply because the periods on which the expense and activity figures have been established were either above or below normal. There is an erroneous policy pursued by many cost men, of taking the expense figures for one year and using them as a basis for those of the next year, without making the necessary adjustments for abnormal causes: in other words, they fail to consider the matter in the light of the future. Such examples are numerous, and methods of this kind invariably result in disaster to the entire cost-accounting scheme, simply because of neglect, on the part of those responsible, to exercise the necessary judgment and foresight.

Making the Necessary Adjustments.—After the normals have once been established for a factory year, they must then be adjusted in detail with respect to the various component parts of the shop organization. In the modern well-managed factory, each producing department is practically a distinct entity in itself and, as such, may be treated in much the same fashion as though it were a distinct shop. Each of these departments buys its own power, rents its own floor space, pays for its own heat, light, and service, in much the same way as if it were a separ-

ate and distinct unit. It must therefore be charged with only its just share of the general expenses of the shop, plus those expenses which, under normal conditions, it would itself directly incur.

The normal capacity or activity of a shop may be only 80 per cent of its actual capacity or maximum activity, but all figures used for expense-distribution must be based on this normal degree, and not on any that is either smaller or greater. The method of adjusting variations between the actual current activity and the established normal activity I shall discuss fully in a later chapter, under the heading of "Current Variations," but such adjustments should not be allowed to have any bearing whatsoever on the basis used for assessing the expense loading to current costs. Variations of this kind may, or may not, be due to a faulty management of the shop, but the cause will be the basis for making the adjustments, as will later be seen.

Process Points.—While the various shop departments usually offer a means of establishing general process points, it is often necessary either to incorporate two or more departments in such a grouping, or to segregate a single department into two or more process points. In the manufacture of tin cans, in which the completely finished product is turned out by one machine, there is but one process point, notwithstanding the fact that a number of different operations are performed on one of the automatic machines that are used. Therefore, a department whose equipment consisted solely of these machines would have only one process point.

On the other hand, in a brass foundry there are a number of process points—for example, the core-making, moulding, melting, pouring, and other additional points—each of which represents a distinct process that differs from both the one that precedes and the one that follows it.

The same thing holds true in the machine shop, where different types of machines are located in the same department, and where the work progresses from one to another until it finally leaves the department.

These examples make it clear that in establishing process points a study has to be made of the product, the equipment, and the order of work for each factory, since, even in plants manufacturing products similar to one another, a different physical layout of equipment and procedure of work may require changes in establishing process points. In one plant a machine may be a process point, while in another, the process point may be a workman. In another case that point may consist of a group of machines or a gang of men, and in still others, combinations of men and machines. Each case must therefore be considered individually, with regard to the governing factors.

From the foregoing analysis of the various points of production, it will appear that a distribution of expense can be made on any one of a number of different bases. These, as we have found, are either the shop as a whole, a group of departments, a single department, a subdivision of such a department, or, finally, a single machine or productive operator. The

normal shop expense, heretofore established, is distributable to individual jobs or orders on one or another of these bases. We come naturally, now, to the point of considering the general practice of loading this expense against jobs by one of these different methods.

Percentage-of-Labor-Cost Method of Expense-Loading.—The first method is that whereby the normal shop expense is resolved into a percentage of the productive labor either of the shop as a whole or of any of its various departments. After the normal departmental expense has been established, it is reduced to terms of percentage of the normal productive labor of that department for a period corresponding to that on which the expense has been established. This percentage is then added to every dollar of productive labor applied on jobs or orders as an expense loading.

This method of distributing shop expense is safe only when the productive labor bears a uniform relation to elapsed time, and when it is a function of time. Moreover, it is necessary, when this method is used, that the work be more or less in the nature of a continuous process, that there be no exceptions or interruptions, and that there be a uniform mechanical equipment of the same types of machines. Only under such conditions is this basis of expense-distribution reliable, and as the restrictions cited above limit its application to a very small proportion of shops, its general use is to be frowned upon as an unsafe procedure, from an expense distribution standpoint.

Labor-Hour Method of Expense-Loading.—In an early chapter of this volume, I devoted considerable space to showing that shop expense is incurred in proportion to time elapsed. That is the basic principle on which this second method of distributing shop expense is founded. After the normal expense has been established, the normal hours of operation for each department or division of the shop is determined, and then the expense is reduced to a rate per labor hour. Different departments may have different rates, which will vary according to the relation which each one's expense bears to its normal productive hours. This loading is then computed for each order on the basis of the number of labor hours charged against the order by each department that has done work on the order.

While this method of expense-distribution has important advantages as compared with the labor-cost method, it nevertheless falls far short of the point where it could be considered a safe basis on which to compute costs. Its inadequacy is due to the fact that no differentiation is made between the various classes or types of machine tools that are used as aids in production.

Take, for example, the case of three operatives who are working, side by side, on three entirely different types of machines. One of these men, we shall say, operates a punch press, another a single-spindle drill, and the third an automatic screw machine. Now, if each of these three employees happened to work a period of ten hours on their respective jobs, the expense loading that would be assessed

against all three jobs would be exactly the same. The reason is that an expense rate per labor hour has been established for that department, and this rate would be used in each case. Since the hours of operation are the same, there would be identical expense loadings for all three jobs. Then, if each of the operators received the same wage rate per hour, and happened to use exactly the same amount of raw material, in terms of value the cost of manufacturing, also, would be identical for all three jobs.

We know, however, that it costs more to operate some types of machines than it does others, and in this case it is apparent that there is a considerable variation, in the operating expense per hour, between the light drill press and either the heavy punch press or the hard-working automatic screw machine. If the expense were actually reduced to a machine-expense rate per hour, we might find that the drill press cost was \$0.06, the punch press \$0.12, and the automatic machine \$0.18. Therefore, the first would be equivalent to an expense loading of \$0.60 for the ten hours worked, the second \$1.20, and the third \$1.80. The maximum variation, then, between the expense of operating the drill press and that of the automatic screw machine would be 200 per cent.

Weakness of Labor-Hour Method.—It is therefore evident that the weakness of the labor-hour method of expense-distribution is attributable to the fact that when it is used, simply the operator, and not the machine, is considered. This is one reason why some plants that use this labor-hour method cannot reconcile their cost figures with what they know certain

jobs should actually cost. Moreover, the management wonders why competitors can sell certain goods at prices below what it actually costs to manufacture the product. The reason is self-evident when the matter is considered from the standpoint of machine-operation expense.

Just why this important point is continually being lost sight of by manufacturers and accountants alike, is a mystery. The fact remains, however, that failure to appreciate the danger of such methods of cost finding as those which I have recently mentioned has been the cause of many of the industrial wrecks that we have seen shattered on the rocks for no apparent reason.

There are, of course, exceptions to every rule, and in this case the exceptions are those plants which, because of a uniform machine equipment, can use the labor-hour method with safety. The proportion of such plants is, however, so small that they immediately are classed as exceptions to the general rule.

How to Obtain Accurate Expense-Distribution.—The analysis that I have here made of the different methods used for distributing the expense burden of the shop, shows that unless both the man and his machine are considered in the unit-expense rate, the desired result—namely: the distribution of the entire shop expense over the output—cannot be accomplished. This analysis further emphasizes the fact that the greater the allocation of expense, the more accurate will be the assessment against each order worked on in the factory. As this allocation finally

resolves itself into the machine-hour rate, which includes the administration expense incurred by the operator, the solution of the problem of accurate expense-distribution is found in the machine-unit system, supplemented by the current-variation rate. I shall discuss these two factors in the following chapters.

CHAPTER XX

THE MACHINE-UNIT SYSTEM

The Machine Hour Rate.—The ultimate objective of all shop-expense allocation is a segration of this expense according to production units. From the various methods explained in the preceding chapter, we have seen that these units may be either general divisions of the shop as a whole, departments in which manufacturing work is done, process points in these departments, or the machines proper.

Our special interest in this chapter is the method of allocating the charges for shop expense so that each machine may be considered as a distinct unit, bearing its own share of the total expense. This method is known as the Machine-Unit System of shop-expense distribution. When supplemented with what is known as the Current-Variation Rate, which I shall explain in a following chapter, it is unquestionably the most scientific of all methods that have as their objective the just assessment of shop expense on to the output of the factory.

The machine-unit system differs from all the other methods in that it differentiates between different kinds of machines, and establishes a relationship between the output of each machine and its operating cost. This is accomplished by resolving into a rate

per hour the annual expense of operating the machine. Then, given the expense loading for each hour a machine is operated, the total assessment for shop expense against any job worked on by a machine can be easily determined by simply multiplying the rate per hour by the total machine hours charged against the job. To this expense loading is then added the cost of the raw material used and the productive labor wages that were incurred in operating the machine.

Now if it were possible to determine accurately in advance the actual annual expense and hours of operation of each machine, the machine-unit system would be the acme of perfection from an expense assessment standpoint. The difficulty, however, lies not only in establishing the proper proportion of the total shop's expenses which each machine must bear, but also in establishing the so-called "normal hours" of operation for each machine. These normal hours directly affect the rate, since each machine's rate is established by dividing the total estimated expenses of operating the machine by its yearly normal hours of operation. Therefore, an error made in determining these normal hours will cause as much trouble as an error in estimating the expense of operating the machine.

Normal Hours Must Constitute Safe Basis.—The method of establishing these normal hours of operation was discussed quite fully in the preceding chapter, but it is not amiss to call attention again to the fact that they must be based on past experience, present nowledge and a proper regard for the future.

In other words, they must constitute a safe basis for computing costs and selling prices.

While the normal hours of operation of machines in one department of a factory may be 2,600 per year, the hours in another department may be only 1,300. This difference may be due to certain controlling physical conditions pertaining to the layout of the shop, or to factors governed by the particular product in process of manufacture.

It would not be possible to lay down any fixed rule without citing a long line of exceptions, but the important point which I wish to bring out is that in only rare instances can the shop be considered as a whole, when normal hours of operation are being established. Consequently each department, and possibly even each machine, may have to be considered as a distinct entity.

To this end, it is important that a study of the shop's expenses be made at least once every year, and likewise that a study be made of the future manufacturing procedure or policy of the company as a whole, which may necessitate a change in the hours of operation which, prior to the time of investigation, were considered normal. For example, a change in the method of setting aside reserves for depreciation of the machine equipment may have to be made, because of the fact that the old rates for depreciation were wrong. Again, it may be found that the cost of oils or other supplies that are used to keep the machine in operating condition, may have advanced in price, or the pay for millwrights' work or other non-productive labor may have been in-

creased. Any or all of these factors, together with many others, which the reader will call to mind, may make it necessary to establish a new "normal" for shop expenses.

In the same way, a shifting or regrouping of machines throughout the factory may necessitate a changing of the normal hours. All of these possibilities have to be considered by the engineer or the accountant when an effort is being made to establish true costs of production, and, because the success of the machine-unit system is subject to so many controlling factors, the need for some means of control, even during any one year, becomes obvious. This control is provided by the current-variation rates, but before we can take these up for consideration, it is essential that we gain a comprehensive idea of just how the machine rates are computed.

Classifying Machines According to Standard.—The first step after the normal expenses of the shop for a current year have been established, and segregated by departments or process points, is to classify the various machine types according to some arbitrary standard. For example, in one of the plants where I personally supervised the revision of machine rates, the plan according to which the main productive machine types were classified was the following:

Lathes
Screw Machines and Miscellaneous Lathe Types
Milling Machines
Drill Presses
Grinders
Buffers and Polishers

Tappers
Punch Presses
Shears
Metal Planers
Hammers (Mechanical)
Metal Saws (Mechanical)
Sheet-Metal Rollers and Formers
Furnaces, Forges, and Annealing Machines
Anvils and Surface Plates
Jointers and Planers
Moulders and Shapers
Sanders
Wood Saws
Mortising and Tenoning Machines
Benches (For Productive Work)

After a division of the main machine types has been made, they are then further classified according to machine functions. For example, lathes, while classified as only one type of machine, in the preceding general classification list, were further subdivided as follows:

LATHES:

Turret
Engine
Tool-Makers' and Precision
Rapid Reduction
Hand and Speed
Wood-Turning
Backing-Off
Gear-Cutting
Gap-Engine

Each of these lathe types is then further sub-classified according to size, capacity, and so on, until all types can be included in one or another of the classes

that have been established. For instance, turret lathes would be segregated according to size of stock, swing, and length of bed. Each group of the same class would then be denoted by some sort of numeral or alphabetical-series classification, as will be seen from the system used in the following sub-classification of turret lathes:—

TURRET LATHES

Size of Stock in Inches	Swing in Inches	Length of Bed in Inches	Class
½ x 10 to 1¼ x 10	10 to 14	4 to 7	LA
1¾ x 8 to 2½ x 12	15 to 18	7 to 10	LB
(Heavy Type) 2 x 24	12 to 16	8	LC
(Heavy Type) 3 x 36	19½	9	LD
(Heavy Type) 12 x 40	21	9	LE

This same method of grouping machines of the same types and capacities is extended to embrace the entire machine equipment of the shop. By this method, comparisons can later be made between the final machine rates established for machines which are of the same kind, size, and capacity, but which are located in different departments of the shop.

Factors Governing Machine Rates.—The fact that a machine in one department is exactly the same as a machine in another department, is no reason for assuming that the expense-loading rates will be the same. While the actual expense of operation may be the same for both machines, the administration charges made may be heavier in one department than in another.

In like manner, the normal hours of operation may be greater or less for one machine as compared with another of the same kind in some other department. Any of these factors would be conducive to a machine rate that might be either above or below that of a similar machine located elsewhere. Therefore, when the rates have been finally determined, comparisons can be made which will often result in a rearrangment of the machine equipment so that the cost of doing a certain kind of machine work will not suffer just because the work happens to have been routed to a department where the machine rate, on the same kind of machine, happened to be higher than that on the machine in the first department.

Now, it does not necessarily follow that this comparison of machine rates will result in a rearrangement of the equipment, since other factors—such as sequence of operations and elimination of time wasted in sending the work to the department with the lower machine rate—may more than offset the difference between the two rates. However, the solution of such a problem as this is not so much what we are interested in, at this point, as the fact that variations of this nature can be brought to light by a comparison of machine rates.

Differences between Expense-Loading Rates.—Having seen, then, that two or more machines of exactly the same type, style, and capacity may have different expense-loading rates, because of their location, it is necessary to incorporate in our system of machine classifications some method of distinguishing between such cases. This is necessary because, when

a report is made of the time of an employee who works on any machine, the classification number or letter of his machine is noted on his job-time ticket; and if the machine class represented a loading of ten cents an hour, all machines of this class (say LA) would take the same rate, irrespective of location. Therefore, in order to differentiate between those machines which are of the same class, but which have different rates because they are differently located, an additional class letter is apended to the original classification, as follows:

L A	10 cents	per	Hour
L A B..........	11 "	"	"
L A C..........	12 "	"	"
L A D..........	14 "	"	"
L A E..........	17 "	"	"
L A F..........	18 "	"	"

If this plan is adopted, the cost department, which has a record of the corresponding rate for each class, will experience no difficulty in extending the proper rate for any machine. Each machine should have a plate, bearing its classification number or letter, permanently attached to it in such a position that it can be easily seen and referred to if necessary. The class letters are used in order that the machine operator may not know what his machine rate is. The departmental clerks soon come to know the number or letter of each operator's machine; in fact, after using these designations for a short time they do not have to refer to the machine plates. These class marks should not be stamped on the plate that bears

the machine number, as it is often necessary to change the class plates and these may become mixed or lost before replacement, in which case confusion in the records would result. A plate of the kind and size here shown has been found very satisfactory for this purpose. The letters are stamped on the plates by hand with small metal dies.

Productive and Non-Productive Units.—The reader will recall that in an earlier chapter, devoted to a discussion of the classification of the plant equipment, the machines were divided into two groups: standard types and miscellaneous types, respectively. The former group included all such machines as lathes, punch presses, screw and milling machines, drill presses, planers, and so on. The latter group included all such non-portable equipment—which is used in production work—as tanks, kettles, vats, ovens and furnaces.

While the standard types of machines are generally used directly for production, the miscellaneous types are quite often used only as adjuncts to the regular machine equipment, and, as such, must be included as parts of a productive machine. For example, a water tool-grinder might be a necessary adjunct in connection with the operation of a group of

twelve drill presses, since the operators of these machines would require the water tool-grinder to sharpen their drills. In such a case, the expense of maintaining the grinder would be chargeable against the twelve drill presses.

While the grinder used in the foregoing example would be included in the group of miscellaneous machines, it is also classified as a non-productive machine. On the other hand, a large number of other miscellaneous machines, such as ovens, tanks, kettles, and so on, might be classified as productive machines, for they are used directly in producing. A plating tank, for instance, contributes directly in a productive capacity, but is nevertheless included in the miscellaneous machine group. In some isolated cases, certain standard-type machines may even be put into the non-productive class, because they are used simply as adjuncts to productive machines. While such instances are rare, they should nevertheless be considered from an expense-loading viewpoint.

From the foregoing analysis of the machine equipment, it will become apparent that all machines in a factory, whether classified as standard or miscellaneous types, can be divided into two groups, namely productive and non-productive machines. It does not necessarily follow, however, that all productive work has to be done on machines.

A large part of the actual production work in most factories is done at benches; these benches are therefore productive units, just as machines are. But all benches are not productive, for exactly the same reason that all machines are not productive. A

workman operating a machine may use a bench for holding his tools; in such a capacity it becomes simply an adjunct to the machine, and is classified as non-productive.

It is therefore evident that the machine and bench equipment of a shop can be divided into the following four distinct groups: Productive machines, non-productive machines, productive benches, and non-productive benches.

Productive and Non-Productive Machinery Defined.—A productive machine may be defined as a machine which is used by a workman in actual manufacturing, and against which time is turned in for work done on it.

A non-productive machine is an auxiliary which is used in conjunction with a productive machine, and against which no time is turned in for work done at it.

A productive bench is a bench, or even in some cases floor space, which is used by a workman in actual manufacturing, and against which time is turned in for work done at it.

A non-productive bench is a bench which is used as an auxiliary to a machine or a productive bench, but against which no time is directly charged.

After the machines and benches have been classified according to these four groups, a card record should be made of each and every bench and machine, and the non-productive units should be filed separately from the productive ones. It is important that a careful study be made of the non-productive units, with a view to assessing them against the

proper productive units. I shall explain more fully further on the way in which the expense assessable against these non-productive units is absorbed by the productive units, but it is especially important to note at this point the necessity for exercising all possible precaution, in order that no errors may be made in loading the expense of a non-productive unit against a productive one, which does not use it.

Analyzing Shop Expense By Classes.—After the equipment has been divided into groups of productive and non-productive units, the question of determining the normal expense of maintaining each productive unit for the current year must then be considered. We have found that all of the shop expenses can be finally grouped under two main headings, "Machine Expense" and "Material Expense," respectively, and that the different sub-classes of shop expense such as administration, power, rent, and so on, which have been discussed and analyzed in preceding chapters are all finally closed out into either "Machine Expense" or "Material Expense."

As previously defined, this machine expense consists of all expense other than that incurred in connection with purchasing, handling, receiving, storing, and accounting for material. It is represented by the balances of the various sub-classes of shop expense after all transfers for service have been made. For example, while practically all power expense is chargeable to machine expense, a certain portion has had to be charged to material expense for operating freight elevators, and so on. In the same way, a portion of the total rent expense was found to be charge-

able to material expense on account of the use of floor space in connection with material. The machine expense, therefore, represents the total of the balances that remain after all transfers have been made.

In order to get at this matter in a more concrete form, let us asume that the total shop expense that has been determined upon as normal, amounts to $500,000, divided according to first classification as follows:

ANALYSIS OF NORMAL SHOP EXPENSE BY CLASSES

Administration and Clerical Expense	$50,000
Power	25,000
Rent	60,000
Tool	220,000
Fixed Charges { Depreciation, Insurance, Taxes }	100,000
Idle-Labor Expense	5,000
Material Expense	40,000
Total	$500,000

After distributing administration expense on the basis of employees, power on the basis of kilowatt hours consumed, rent on the basis of floor space occupied, and so on through all of the subdivisions mentioned above, it is found that the charge to material expense is considerably altered, because of the service charges brought forward from these other divisions of shop expense. Let us assume that these transfers were made as follows:

Classification of Expense	Chargeable to Machine Expense	Chargeable to Material Expense	Total Shop Expense
Administration and Clerical....	$ 45,000	$ 5,000	$ 50,000
Power........................	23,000	2,000	25,000
Rent..........................	40,000	20,000	60,000
Tool..........................	220,000	......	220,000
Fixed Charges................	90,000	10,000	100,000
Idle—Labor..................	5,000	......	5,000
Material.....................	......	40,000	40,000
Total.....................	$423,000	$77,000	$500,000

This analysis shows that the original direct charges of $40,000, to material expense have been supplemented with additional service charges to the extent of $37,000, and that therefore there is a total charge of $77,000 against material expense. The machine expense balance of $423,000 is the amount which we are interested in distributing to jobs, by means of an hourly rate on each productive machine or bench in the shop. The material expense is assessed against jobs on the basis of bulk (or weight) of the material charged thereto.

Rates For Machine-Expense Distribution.—Considering, therefore, only that portion which is to be distributed by means of the Machine-Unit System, let us establish the rates by which each of the different subdivisions of machine expense are to be distributed to production centers. This distribution is accomplished by dividing the total for each class of expense by the number of units in each case. For instance, the total for administration and clerical ex-

pense is seen to be $45,000, and the number of units 900 employees. Therefore, the rate is $50 per employee. Rates for these various classes of expense are determined as follows:

Expense Class	Amount	Unit Basis of Distribution	No. of Units	Rate Per Unit
Administration and Clerical	$45,000	Productive Employees	900	$50.00
Power: Steam	3,000	Pounds of Steam	7,500,000	.40 Per M
Power: Electric Current	18,000	Kilowatt Hours	900,000	.02
Power: Compressed Air	2,000	Cubic Ft. of Free Air	18,000,000	.11 Per M
Rent	40,000	Square Feet of Floor Space	65,000	.6154
Tool	220,000	As Incurred	220,000	....
Fixed Charges	90,000	Face Values	900,000	10%
Idle-Labor	5,000	As Incurred	5,000	....
Total Expense	$423,000			

When unit bases for distributing all classes of shop expense have thus been established, it is necessary to apportion that expense, first by departments, then by additional production centers if this is necessary, and finally by machines.

Shop, and Departmental Administration, Charges.—Before proceding with this work, however, it is necessary further to allocate the administration expense so that the general administration charges incurred by the shop, as a whole, may be kept separate from the departmental administration charges. We find, by referring to the foregoing table of unit rates, that the administration rate is $50 per employee per year. But we know that it would not be fair to assess this equally to all departments on the basis of the number of employees in each, for the reason that in some departments of the shop a much greater number of men are supervised by one fore-

man than in other manufacturing departments. Therefore, if we distribute the total administration expense over the whole shop on the basis of $50 for each employee, those departments that have a lower departmental administration charge per employee would be bearing the higher cost of other departments.

Hence, it is obvious that before distributing this total administration expense of $45,000, we must first determine how much of the total is common to the shop, as a whole, and how much of the balance is chargeable to each manufacturing department. In order that this method of determining both a general and a departmental administration rate per employee may be still clearer, let us assume that, on analysis, we find the total administration expense to be divided first as to expense common to the whole shop, and second that incurred directly by manufacturing departments. This may be shown as follows:

Common to whole shop....................	$ 9,000
Incurred Directly by Mfg. Depts...........	36,000
Total..................................	$45,000

Then, from the above figure of $9000 for general administration expense, we can determine a rate per employee by dividing this amount by 900 (employees); the result of this computation is a general administration rate of $10 per employee. In other words, for every employee in a manufacturing department, that department must bear an annual charge of $10 for general shop administration.

Department Administration-Expense Rate.—Upon further analysis, we shall assume that the $36,000 remaining has been incurred as follows:

Department	
A	$4,500
B	3,600
C	6,300
D	2,700
E	4,500
F	3,600
G	1,800
H	2,700
K	3,600
M	2,700
Total Departmental Administration Expense	$36,000

Now, if we set alongside each department's local administration expenses, as determined by the above analysis, the number of employees in each department, we can readily determine a rate per employee by dividing each department's expenses by the number of its employees. The table on page 421 shows how these rates compare as regards different departments of the shop.

An inspection of these departmental administration rates will reveal a considerable variation between different departments, and will also show the injustice that would have been imposed on some of these departments if the total administration expense of the shop had been applied as a whole, instead of along the lines herein followed.

Department	Normal Departmental Expense	Normal Number of Employees	Local Departmental Rate Per Employee
A	$4,500	100	45.00
B	3,600	70	51.43
C	6,300	200	31.50
D	2,700	50	54.00
E	4,500	90	50.00
F	3,600	100	36.00
G	1,800	45	40.00
H	2,700	65	41.54
K	3,600	90	40.00
M	2,700	90	30.00
Total......	$36,000	900	

For example, it will be seen that each of the departments "A" and "F" has 100 employees, but department "A" incurs $4500 a year in administration, while department "F" incurs only $3600. Therefore, the local rate of department "A" is $45 per employee, as compared with only $36 for department "F." An analysis of this kind is often valuable, also, to the executive of the plant, in helping him to determine whether or not increases in administrative rates in certain departments are warranted, when considered in comparison with other departments. For purposes of determining machine rates, a segregation by departments is absolutely necessary, as will be seen by comparing the final combined rates for general and departmental administration, as shown by the table on page 422.

We have thus established a final administration rate for employees working in any department of the shop. This rate will eventually be combined with

Department	Departmental Administration Rate	General Shop Administration Rate	Total Departmental Rate
A	$45.00	$10.00	$55.00
B	51.43	10.00	61.43
C	31.50	10.00	41.50
D	54.00	10.00	64.00
E	50.00	10.00	60.00
F	36.00	10.00	46.00
G	40.00	10.00	50.00
H	41.54	10.00	51.54
K	40.00	10.00	50.00
M	30.00	10.00	40.00

such other expenses as those of power, rent, tools, and so on, etc., and will be reduced to a rate per machine hour.

Tests to Determine Power Consumption.—In Chapter XIII, power expense was analyzed and reduced to a rate for each kind of power—for example, steam cost $.408 per M. pounds generated, and electric current $.021 per kilowatt hour distributed. Therefore, in order to determine the power expense chargeable against any machine, it is necessary to ascertain the number of units of power, of the specific kind used, that would be consumed in a normal year of (X) hours.

In plants where no tests have ever been made to determine the power consumption of the respective machine types, tests will have to be made in order to establish these quantities. The method of making power tests on machines that are directly driven by motors attached to them, is a comparatively simple matter. This method consists simply of connecting

up an ammeter and voltmeter—or a watt meter, if one is available. Readings can then be taken with the machine running under a normal working load for a certain period of time, and the figures obtained can then be reduced to a kilowatt-hour consumption basis.

Power Tests of Line Driven Machinery.—When a test is to be applied to a machine that is operated by a line shaft to which a number of other machines are attached, the method of procedure should be the following:

The line shaft should first be operated light, that is, with all belts to machines disconnected, and the power readings should be recorded. The machine to be tested should then be belted in and operated light —that is, without any load—and the meter readings should again be recorded. Then the difference between these latter readings and the former ones, taken when the line shaft was running light, would give the power consumption of the machine proper.

It is now necessary to determine what proportion of the power taken to operate the line shaft light, should be charged against the machine being tested. Let us assume that ten machines, in all, are operated from this one line shaft, and that these machines are of four different types, as follows:

3 Turret Lathes
3 Drill Presses
3 Automatic Screw Machines
1 Punch Press

We shall assume that the punch press is the machine being tested for power consumption. Then, in

order to determine how much of the line-shaft power consumption should be charged to this punch press, it is necessary to find out what proportion the load of the drill press, when the latter is running under normal operating conditions, bears to that of each of the other three types when they also are running under normal loads. This proportion is determined by taking the power readings on each of the other three machine types when they are operated independently by the line shaft.

We shall assume, further, that this relation, after the line-shaft power consumption has been deducted, is the following:

1 Turret Lathe.................	500	Watts	per	Hour
1 Drill Press...................	150	"	"	"
1 Automatic Screw Machine....	300	"	"	"
1 Punch Press.................	600	"	"	"

Then, multiplying the wattage for each machine type by the number of machines of the same type on that line, we should find that the following would be the comparative loads incurred by each type.

3 Turret Lathes..............	1,500	Watts	per	Hour
3 Drill Presses..............	450	"	"	"
3 Automatic Screw Machines..	900	"	"	"
1 Punch Press...............	600	"	"	"
Total....................	3,450	"	"	"

If we assume that the current consumption in operating the line shaft light was 300 watts, then we should find that the proportionate share of this line

shaft power chargeable against the punch press would be $\frac{600}{3450}$ of $300 = 52$ watts per hour, which, when added to the 600 watts, make up a total power consumption of 652 watts per hour chargeable against this punch press. If the normal yearly hours of operation of this machine are 3500, then its yearly power consumption is $\frac{652}{1000} \times 2500 = 1630$ kw-hr., which, when multiplied by the kilowatt-hour rate, would give the total yearly power expense chargeable against this punch press.

Rates Vary With Type of Power Transmission.— In the modern manufacturing establishment, a large part of the machine equipment is operated directly by motors attached to individual machines. This method of operation provides a more effective control over the power consumption, and also eliminates all the expenses incidental to the upkeep of the mechanical transmission system, with which we are all familiar. Where such a condition as this exists, it is necessary to establish separate rates for power transmitted through the line shafting and that distributed directly to the motors on the machines.

The reader will recall that in Chapter XIII it was shown that while the electric-current distributing expense amounted to \$14,422.57, this did not include the transmission expense of \$3,111.10. If we assume that one third of the 693,522 kilowatt hours on which was determined the rate of \$.021 per kilowatt hour for electric current generated and distributed, is distributed directly to motors on the machines; and if

we further assume that two thirds is transmitted through line shafting, we can then obtain the costs and rates per kilowatt hour for both the power distributed directly and that transmitted through the line shafting. On this basis, the mechanical transmission system would have used 462,348 kilowatt hours per year. Dividing this total wattage into the transmission expense of $3,111.10, will give the expense per kilowatt hour for transmitting; approximately $.007. Then, adding to this the cost per kilowatt hour of $0.21, for generating and distributing the current up to where the transmission system took it over, will give the total rate for electric current transmitted, $.028 per kilowatt hour, as compared with with the $.021 for the current sent directly to the motors on the machines.

Having established this rate for transmitted power, we can now determine what the yearly power expense is which the punch press incurs. Multiplying these 1630 kilowatt hours by this rate would then give us a total power expense of $45.64 chargeable against this machine.

Definition of Terms.—Form 75 on the opposite page shows the method of recording power-test data. In view of the fact that probably a large number of students of this question of cost analyses are unfamiliar with the power terms used, as well as with the methods employed by engineers when they are making power tests of this kind, it may be well to explain the terms used in order that the student of this question have a working knowledge of the subject.

The unit used in measuring the flow of electric current is the ampere. It is the amount of current which would be given with an electro-motive force of one volt through a wire that has a resistance of one ohm. The electro-motive force is expressed in terms of volts. It is the force that causes the electricity to move along the conductor. The ohm is the measure of electrical resistance. The "international" ohm, the unit adopted by the electrical congress of 1893, is the unit now used in measuring resistance. It is represented by the resistance, at the freezing point, of a column of mercury 106 centimeters in length and weighing 14.4521 grams.

Ohm's Law.—The law that combines the relationship of these three units of electrical measurement, is called Ohm's Law. It is expressed as follows: $C=\frac{E}{R}$ in which, C, is the current in terms of amperes; E, the electro-motive force, in terms of volts, and R, the resistance in terms of ohms. In common parlance, this law means that in any electric circuit the strength of the current is equal to the electro-motive force divided by the resistance. Therefore, it will be seen that if the resistance is increased and the voltage maintained, a smaller amount of current will be able to pass than was originally the case. In the same way, if the electro-motive force is increased, a greater amount of current will pass over the same circuit. Therefore, if the voltage of a factory is known, and the current consumption is measured by an ammeter, the resistance of a circuit can be readily computed.

Power in Terms of Watts.—What we are especially interested in however, is the problem of expressing the power in terms of watts. The watt is the practical unit of electric power, activity, or rate of work. The value of a direct current in watts is equal to the product of the values of the current and the electro-motive force. In other words, if we know what the voltage and amperage of a circuit are, we can easily determine the number of watts, by multiplying the current by the voltage. There are 746 watts to a horsepower, and 1000 watts to a kilowatt. All electric current is measured in terms of kilowatt hours, and therefore, after the total wattage for a year is determined, this is then reduced to kilowatt hours by dividing by 1000.

Assessing Rent Expense against the Machines.—Reference to Chapter XIV will show that after the application of all effective floor space of the shop against the total rent expense, a rate of $0.5133 per square foot was established. This rate is now used in determining the proportionate amount chargeable against each machine. This amount is found by carefully measuring the floor space occupied by each machine—including the projected obstructive area used when stock is in the machine, and also whatever additional space may be essential to its operation and maintenance.

This computation is made for all productive and non-productive machines. For example, a water tool-grinder used as an adjunct to some drill presses would be considered as a distinct entity, not only when the rent expense is assessed, but also when

administration, power and other kinds of expense are being assessed against it. After these expenses chargeable against non-productive machines are all assembled, the entire expense is then assessed against the productive machines to which it is an adjunct.

Importance of Distributing All Floor Space.—It is of paramount importance that all the floor space charged to machine expense be finally assessed against either productive or non-productive machines, benches, or erection areas, in order that all the rent expense charged to machine expense may be distributed, in the course of a year, as a part of the machine rates. Unless this is done, a balance will remain in the Rent Expense Account as undistributed, and the unit costs for that period will be wrong.

If we assume, therefore, that the punch press under consideration occupied a space 5 x 8 feet, then we shall find that the area of 40 square feet multiplied by the rate of $0.5133 per square foot, would make the yearly rent charges against this machine $20.53. This same procedure is followed for all machines, benches, and erection areas throughout the shop. Any undistributed part of the total area charged to machine expense, must be pro-rated among the machines, on the basis of the proportionate amount of floor space that they use. It is therefore important that the total machine-expense area be accounted for before an attempt is made to compute the rent expense chargeable against any machine.

Analyzing Tool Expense by Types of Machines.—We have so far determined the amounts of Admin-

istration, Power, and Rent Expenses that can be charged against this punch press. The next class of expense to be considered is Tool Expense. This is determined by dividing and subdividing the total tool expense of the department in which the machine is located, until it can be finally charged against each productive and non-productive machine or bench in the department. The distribution sheet on this page shows how this expense is analyzed by types of machines.

Expense Classification of Tool	1 P. & W. Turret Lathe	11 Bliss Punch Presses	3 Single Spindle Drill Presses	4 Unit Tool-Grinders	Total
Belting	$ .50	$ 50.15	$1.51	$2.19	$54.35
Changes to Small Tools	2.40	19.45	2.59	1.75	26.19
Changes to Machinery	.15	2.10	.40	.35	3.00
*Depreciation of Tools and Shop Fixtures	......	......	......	......	......
*Insurance on Tools and Shop Fixtures	......	......	......	......	......
*Taxes on Tools and Shop Fixtures	......	......	......	......	......
Repairs to Machinery	12.00	140.25	55.20	65.00	272.45
Repairs to Tools	46.00	226.00	20.19	17.15	309.34
Repairs to Patterns	......	......	......	......	......
Salaries: Clerks in Tool Stock-Rooms	9.00	75.95	8.40	4.92	98.27
Tool-Inspectors	6.00	48.61	5.18	2.65	62.44
Machine-Oilers	4.50	40.59	6.00	2.95	54.04
Setting up Machines for Operations	102.00	56.80	24.90	66.80	250.50
Setting up New Machines	12.00	102.10	29.75	31.10	174.95
Supplies, waste, oil, etc.	15.60	12.40	3.43	4.01	35.44
Water (for use on machines)	......	......	......	......	......
Total Tool Expense of this Department	$210.15	$774.40	$157.55	$198.87	$1340.97

*Applied separately on machine-rate summary sheet.

It will be noted that in analyzing the tool expense charged against machine types, depreciation, insurance, and taxes on small tools are not included, for

the reason that they are applied separately on the machine-rate summary sheet, and are based on the face value of the machines and the tool equipment charged thereto.

Segregating Fixed Charges.—Depreciation, insurance and taxes are charged to each machine unit at predetermined rates. These rates are arrived at by taking the total investment in the manufacturing equipment at face value, and dividing this into the total expenses incurred through charges made for depreciation, insurance, and taxes. For example, the total fixed charges against the shop may be $100,000, and the investment in equipment $1,000,000. Then a rate of 10 per cent applied to each machine, on the basis of the original value of the machine and its tool equipment, would absorb the total fixed charges over the period for which they were estimated.

Benches are classified as shop fixtures. Therefore, when bench rates are computed, the investment values are found in the Shop Fixture Account instead of in the Machinery Account. Depreciation, insurance, and taxes have different rates, respectively, when computed independently on the basis of face values of equipment; for purposes of machine-rate determination, however, a combined rate for all three is more practicable. Therefore, when this rate has been determined as 10 per cent, it is a comparatively simple matter to apportion the fixed charges to each machine, or equivalent manufacturing unit, on the basis of face values which, of course, will have been properly determined.

Idle-Labor Expense.—This class of shop expense is first segregated by departments accordinig to the basis on which it has been incurred, provided each department is solely responsible for its own lost time. It very often happens, however, that while a certain department may have a large amount of idle time charged against it, the fault may be that of other departments, from which the goods in process have been forwarded. Analysis may even show that the trouble can be traced back to the planning department. In such instances, the cost of this idle time should be distributed to all departments, on the basis of the proportionate amounts of productive-labor expense incurred by them during the year.

When idle-labor expense is incurred through the failure of the sales department or of the general management to provide sufficient work to keep the shop busy, and when the shop management has not been advised of shortage of work in time to lay off extra help, the expense so incurred should not become part of the expense burden of the shop proper, but should be charged back to the general management as an expense due to inefficiency on its part.

Machine-Rate Summary.—We have now established a basis for charging each and every machine in the shop with its proper proportionate share of the total normal shop expenses. These must now be assembled, in order that they may be reduced to a machine-hour rate. Therefore, in order to do this, let us assume that the punch press under consideration cost $250. Then its total expenses for the year would be the following:

MACHINE-RATE SUMMARY SHEET

Face Value of Machine, \$250. Of Tools, \$6,500. Total, \$6,750.
Description of Machine—Style A Punch Press.
Machine Classification—P. P. A. B.
Number of Machines in Class (1) in Dept. A.

1—Administration: General Rate per year..=\$10.00
" Departmental Rate per year ....= 45.00

Total Administration Rate per Employee per year.............................=\$55.00
Normal Yearly Hours of Machine Operation 2500

Administrative Rate per Hour per Employee ....\$.022

2—Power:
Kind: Current Transmitted
Units per year: 652 Watts×2500 Hrs. =1630 Kw-hr.
Rate per unit \$.028 per Kw-hr.
Total Power Cost per year.............\$ 45.64

3—Rent:
Sq. Ft. Floor Space Occupied=40
Rate per Square Foot....\$.5133
Total Rent Expense........................ 20.53

4—Tool Expense (See Tool Exp.=1/11 of Punch Press Exp.)................................ 234.92

5—Fixed Charges:
Face Value Mchy. & Tools, \$6,750
Rate 10%
Total Fixed Charges........................ 675.00

6—Idle-Labor Expense (Arbitrary Amount)....... 12.00

7—Non-Productive Machine (Adjunct) Expense.... 55.00

8—Total Machine Expense (Not including Adm.)..\$1,043.09
Rate per Hour................................\$ 0.417
Plus Adm. Rate on 2 men {1 Prod. Mch. Oper. / 1 Asst. " "}.\$ 0.044

9—Total Machine Rate per Hour.................\$ 0.461

The hourly machine rate for this punch press is therefore \$0.461, which includes the loading for the expense incurred by a non-productive unit used as an adjunct to the punch press (see 7 above). It includes also the administrative charge against an assistant, whom the punch-press operator evidently uses as a helper. The administrative charge thereto is twice \$0.022, or \$0.044.

The reason for keeping the administration expense separate from the direct expenses of a machine, when summarizing, is to be found in the fact that it is often necessary to spread this administration expense of one operator over several machines. A concrete example of this situation is found in the case of automatic screw machines where one man may be tending a half-dozen machines. In such a case, each machine rate would include only one-sixth of the administration expense per hour, plus the direct expenses chargeable against each machine for power, rent, and so on. In like manner, it is often necessary to charge two or more men's time against one machine.

Recording Machine Classifications and Rates.—After the machine rates have been established for the entire plant, the rates are then entered in a reference book, alongside the alphabetical classification of each machine. One of these reference lists is then given to each person duly authorized to use them either for estimating, reference, or cost-determination purposes. A specimen list of this kind containing the information relative to the machine rates in all departments is shown on the opposite page.

MACHINE CLASSIFICATION AND RATE LIST
DEPARTMENT 254

Machine Classification	Rate per Machine Hour
A A B C	$ .201
A B C C	.122
B L A A	.417
B M A	.078
C A L	.251
D K L B	.122
E K K E	.146
M L C D	.109
P P A B	.461
S L A R	.192

The proper class letter is then entered on each time ticket by the foreman's clerk, and when it reaches the cost department, the time charged against the job in question is extended, at the corresponding rate, to obtain the expense loading. In the case of the punch press in question, the machine-hour rate of $0.461 would, if applied over 2500 hours of work, absorb all of the expense of $1043.09 charged against that machine. In like manner, all other productive machines in the factory would absorb their expenses if each of them were operated the exact number of hours on which their respective rates were based.

However, these estimates will in all probability be either in excess of, or less than, the actual hours which the machines will be operated, and therefore the estimated normal expenses of the shop either will be over-distributed, or will leave an undistributed balance, as the case may be. Furthermore, a variation may be caused by the shop's running at an activity either above or below that which was estimated. This will be discussed in Chapter XXII.

CHAPTER XXI

SPECIAL PROCESS EXPENSE UNITS

Exceptions to Machine Units.—From a shop expense distribution view point, the machine unit system, when supplemented by the current variation method of adjusting differences, is undoubtedly far more accurate than any other method of expense distribution. The very fact, however, that it is based on individual machine units does not make it applicable to all manufacturing establishments, for the reason that the work of many of these is of such a nature that it cannot very well be divided according to individual machines. For example, in a brass foundry, machine-hour rates would not be at all applicable, because, in the first place, it would be impossible to split up the expense of operating the furnaces used for melting the ingot metal according to jobs or orders.

In brass foundries, the metals are melted according to different mixtures. In one foundry there may be as many as ten different mixtures of metals being melted at one time in different furnaces, and any one of these ten mixtures may be used for several different orders. Therefore, when the metal is ready for pouring, the whole melt of one of these mixtures may be poured into a dozen different molds calling for

that mixture, but comprising, in all probability, six different orders. In order, therefore, to know just how much of the furnace time should be charged to each order, it would be necessary to know exactly how much metal was poured into each mold; and as this could only be obtained after the mold had hardened and the metal had cooled, was cleaned and weighed, the impracticability of using a furnace-hour rate would be readily seen. The logical basis, and the one by which overhead expense is distributed in foundries, is the pound-output basis.

Other Basic Units.—In textile mills, the basis of expense distribution in the weaving rooms is the loom-hour; but in the spinning departments, the expense is distributed on the basis of the number of spindles. In paint factories, the unit used is the gallon, and in sugar refineries and other similar lines of manufacture, where the output is of the mass production kind, the number of barrels or tons of output are used as a basis.

The point which I am trying to bring out is that there are always exceptions to any general rule, and that these exceptions must be carefully considered when the question of expense distribution is being taken up. It does not necessarily follow that the machine unit system is the correct basis for distributing all of the expense in a machine shop, for in certain departments the machine-hour rate would not be practicable. In the painting, japanning, lacquering, and plating departments, for example, a man-hour basis would be much more practicable than a machine-hour basis. Therefore, in such cases as

these, while the major part of the factory may be on a machine unit basis, certain exceptions may have to be made for departments similar to those just mentioned. This, however, should not affect the distribution of expense, but simply the final assessing of it after it has once been segregated according to departments or other general production centers.

Special Department Expense Control.—It may be necessary also to keep the expense of certain departments separate for the reason that the management may be especially interested in watching the cost of operating each individual department. In the plating and dipping department of a factory where large volumes of chemicals are used, the extent of the purchases of such supplies would need very careful supervision, since they would undoubtedly amount to the greater part of the whole department's expenses during any period. By referring to the report of special departments' expenses, on the opposite page, which is a duplicate of an actual report made in a manufacturing plant, it will be seen that in the Dipping Department, for instance, out of a total expense of $7,024.75, the oils and chemicals amounted to $4,352.36, and in the Plating Department, out of a total expense of $20,101.48, oils and chemicals accounted for $16,272.31. Therefore, expenditures of this kind in these departments would necessarily have to be shown up so that they would not escape the attention of the management.

The unit of expense distribution for a special department is naturally subject to determination on the basis of the function of work performed by such

REPORT OF SPECIAL DEPARTMENTS EXPENSE FOR YEAR 19....

	Brass Foundry	Painting Department	Dipping Department	Experimental Department	Japanning Department	Lacquering Department	Plating Department	Total
Depreciation	$ 69.46	$ 197.16	$ 426.13	$ 111.45	$ 165.47	$ 27.93	$ 392.05	$ 1,389.65
Insurance	1.42	2.23	1.25	1.46	2.09	.14	7.56	16.15
Taxes	5.08	8.87	4.61	4.30	4.05	.47	30.62	58.00
Defective Work	....	....	....	....	1.75	....	30.00	31.75
Repairs Miscellaneous Machinery	4.25	19.07	135.50	....	36.00	....	116.75	309.57
Changes to Machinery and Tools	....	10.48	....	.56	....	36.50	5.43	41.85
Oils and Chemicals	.98	51.21	4,352.36	6.39	40.49	778.10	16,272.31	21,901.84
Fuel	240.09	....	....	....	....	....	....	240.09
Stationery	1.44	12.00	5.24	6.84	15.59	3.64	14.46	59.21
Water for Manufacturing Purposes	....	.11	58.41	....	1.71	....	527.51	587.74
Wages, Miscellaneous	424.08	....	33.34	859.89	....	1.05	17.83	1,336.19
Sundry Expense:								
Gas	....	....	36.45	....	....	....	....	36.45
Small Tool Repairs	.25	86.03	60.35	11.25	8.00	....	.25	166.13
Numbered Machinery Repairs	5.81	68.54	....	5.71	....	....	.12	80.18
Storeroom Supplies	6.31	12.90	33.59	.87	30.88	57.14	168.04	309.73
Balance Sundry Expense	320.66	395.30	43.37	9.18	.46	8.08	460.49	1,237.54
Tool Expense	33.38	43.16	172.03	33.37	31.49	28.30	196.11	537.84
Power Expense	53.07	118.18	249.44	22.44	1,099.00	19.31	523.12	2,084.56
Administration Expense	445.22	441.35	1,246.38	....	851.24	210.44	941.79	4,136.43
Rent Expense	549.87	229.50	168.30	149.18	513.77	68.70	397.04	2,076.36
Total Expense	$2,161.37	$1,696.09	$7,024.75	$1,221.77	$3,201.99	$1,229.80	$20,101.48	$36,637.25
Units	23,293 Pounds	$1,991.55	$3,752.18	$1,878.36	24,102¼ Man Hours	7,847 Man Hours	37,970¼ Man Hours	
Cost per Unit	$.093 Per Pound Castings	85.2% Of Labor Cost	187.% Of Labor Cost	65.0% Of Labor Cost	$.133 Per Man Hour	$.157 Per Man Hour	$.529 Per Man Hour	

a department. In one case a man-hour basis may be the proper one, while in another the labor cost may be better; in still others the pound output or some other basis may be the most practicable. The accountant has to take all of these matters into consideration from the viewpoint of the nature of the work being done, in order to establish the best unit for distributing the departmental expense. After this has once been done, the cost of doing work in any department then becomes simply a matter of careful calculation.

Overtime.—Still another point to be considered in expense loading, is that of the factory where a considerable amount of overtime work is unexpectedly done during the course of any year. It will be remembered that in arriving at the machine-hour rates, an estimate was made based on past and present experience of the probable activity as represented by the hours of operation which any machine would run in the course of any one year. Such an estimate would naturally include any overtime which the machine would be normally expected to run in the course of such a period, but it would not provide for any abnormal conditions such as might be necessitated if the factory took on a larger volume of work, requiring overtime production, or accepted rush orders which would in like manner require such overtime.

It will be seen, therefore, that if we have to distribute $1,000 worth of expense over a period of 1,000 hours, our rate per hour would be $1.00, but if we charged $1.00 for each hour that the factory were

operated, and the hours of operation were increased to 1,500 a year because of overtime work, we would naturally distribute $1,500 worth of expense or $500 more than was actually incurred by the machine for which the rate of $1.00 was originally figured. Such conditions as these are not at all uncommon, and very often are the cause of great errors in cost calculations. When such a condition arises in the average factory, it does not usually last for more than a few days or weeks at a time. In fact, the usual cause of trouble is found when only a few hours each week are incurred by machine operators on overtime work. But if the condition is spread over a period of six months or a year, the total excess machine hours amount to a considerable factor and cause a corresponding error in the amount of expense distributed to orders.

Analyzing Causes of Overtime.—The remedy lies in a careful analysis of the actual cause of overtime. It is important to ascertain the length of duration and to segregate the regular day hours from the overtime hours. When an operator is called on to work two or three hours extra in the evening or on Saturday afternoon, as the case may be, he usually receives time and a half or double time. Therefore, the cost of producing a certain piece of goods may be increased considerably as a result of this overtime. At the same time, the cause of the overtime work may be that some rush order has had to be completed during the day time, and the job now being worked on as overtime has been side-tracked to make way for it. Therefore, through no fault of the depart-

ment management in handling the overtime order, its cost of production may be considerably higher from extra overtime wages paid to the operator. Naturally, this causes considerable confusion in making cost comparisons for different periods, as the figures would not show details as to the cause of the increased cost, and the management may be given an erroneous impression.

The cost factor of overtime work is best adjusted by adding no expense loading whatever to work done after the regular factory day is over, but simply including the increased wage rate per hour of the operative with the cost of the material. This tends to equalize the cost more or less with daywork production. Since no expense is included in the cost of the job, it is offset by the increased rate of 50 or 100 per cent paid to the operator for his overtime work. This applies, however, only to conditions where such occasions are abnormal and could not be foreseen at the time the expense rates were established.

Necessity for Revising Machine Rates.—If it is found that the condition may last for several months or even longer, the machine rates affected most must necessarily be revised and reduced so that the total expense absorbed by jobs worked on by machines will not exceed the total expense of the year. The total expense, which was originally considered to be normal, may have to be slightly increased to include additional supplies and power used during the excess periods. The main point, however, to be kept in mind is that revisions should not be made on slight

provocation, but only after a thorough investigation warrants such action. This question of excess expense distribution is a very important factor, and while its solution is more or less simple, providing the proper attention is given to it, it is nevertheless apparent that where it is neglected, considerable havoc — from a cost standpoint — will undoubtedly result.

Actual versus Normal Machine Earnings.—Comparisons should be made at periodic intervals between the actual earnings of the machines in the various departments and the normal earnings as represented by the normal expense assessed against them. If it is found, after such a comparison has been made, that a machine has absorbed all of the expense loading charged against it, and also that the hours of operation have been normal, then no further adjustment is necessary. If, on the other hand, the earnings of the machine are less than the expense which it has incurred during that period, the variation must be investigated in order to ascertain whether it is due to a mistake in the reporting of the time or simply to abnormal idleness of the machine.

If a discrepancy can be traced to clerical errors, the offsetting correction should be made; but if, on the other hand, it is due to idle capacity, an adjustment may or may not have to be made in the current costs, depending upon whether the fault in not keeping the machine busy lies with the local department manager or with the general manager of the factory. If the trouble is found to be local, the variation in

expense will then have to be added as an extra loading to all of the jobs turned out during the period by the department in which the machine is located. This, however, will be explained more fully in the following chapter on the current variation ratios, but reference to the following report, which is a comparison of machine earnings with the normal machine expenses, will show the method by which such comparisons can be made at periodic intervals.

COMPARISON OF MACHINE EARNINGS WITH NORMAL MACHINE EXPENSE

Department No.	Machine No.	Machine Rate (cents)	Machine Hours Worked	(a) Machine Earnings	Normal Machine Hours	Machine Rate	(b) Normal Machine Expense	Current Variation between (a) and (b)
215	125	10	200	20.00	250	10	25.00	— 5.00
215	127	11	250	27.50	250	11	27.50	....
215	128	15	220	33.00	250	15	37.50	— 4.50
215	145	10	190	19.00	200	10	20.00	— 1.00
215	159	16	240	38.40	250	16	40.00	— 1.60
215	195	25	250	62.50	250	25	62.50	....
215	205	18	250	45.00	250	18	45.00	....
215	210	16	200	32.00	250	16	40.00	— 8.00
215	229	18	105	18.90	150	18	27.00	— 8.10
215	235	12	215	25.80	225	12	27.00	— 1.20
215	249	15	240	36.00	250	15	37.50	— 1.50
215	267	19	185	35.15	200	19	38.00	— 2.85
Total Department Earnings... =				$393.25	Normal Earnings.		$427.00	—$33.75

Machine Earnings versus Departmental Expenses.—Comparisons should also be made at least once a month between the total machine earnings of each manufacturing department and the current expenses incurred by such departments. At the end of each six months a careful study should be made of these variations in order to determine whether or not they result from abnormal increases in expense caused by extensive repairs or replacements, or whether, through

COMPARISON OF DEPARTMENTAL MACHINE EXPENSE WITH MACHINE EARNINGS FOR MONTH ENDING......191..

Department	Administration	Power	Rent	Tool	Depreciation	Insurance	Taxes	Total Expense	Normal Machine Expense	Current Variation
101	75.80	100.20	150.50	210.00	100.20	25.10	12.15	$ 673.95	—$ 750.15	+$ 76.20
102	80.90	150.00	210.40	423.10	95.10	10.00	15.19	984.69	— 1,210.23	+ 225.54
103	70.10	140.25	180.10	396.20	86.15	29.00	12.10	913.90	— 955.00	+ 41.10
104	90.20	200.40	250.00	584.15	160.20	40.15	14.27	1,339.37	— 1,052.48	— 286.89
105	108.40	405.00	305.50	675.15	180.25	38.00	16.29	1,728.59	— 1,520.14	— 208.45
106	95.60	219.20	275.70	469.10	140.30	34.00	17.15	1,251.05	— 1,095.46	— 155.59
107	106.00	260.25	400.00	676.00	415.35	51.15	14.19	1,922.94	1,900.58	— 22.36
108	101.10	290.15	350.80	548.80	308.40	45.00	13.10	1,657.35	1,496.37	— 160.98
109	70.20	105.10	190.20	337.46	310.40	36.00	12.97	1,062.33	1,219.35	+ 157.02
110	190.40	316.10	507.00	859.59	680.35	64.15	17.15	2,634.74	2,048.19	— 586.55
111	87.65	220.50	202.00	544.00	555.30	45.00	15.00	1,669.45	1,734.63	+ 65.18
112	95.25	308.40	408.00	626.25	519.25	80.20	16.15	2,053.50	2,108.67	+ 55.17
113	102.40	209.20	325.00	545.15	680.20	58.40	17.18	1,937.53	1,518.14	— 419.39
114	208.00	516.90	610.80	828.60	927.15	62.10	25.15	3,176.70	2,969.38	— 207.32
115	89.40	165.75	240.90	555.00	740.10	39.50	14.90	1,845.55	— 2,015.15	+ 169.60
Total....	$1,571.40	$3,605.40	$4,606.90	$8,278.55	$5,898.70	$657.75	$232.94	$24,851.64	$23,593.92	—$1,257.72

a change in the policy of routing orders, some machines are being discarded on certain operations for others of a newer or more efficient type.

The current expenses of each department should be analyzed as shown on the report opposite, and the totals of each division of shop expense, incurred during such a period should be compared with the normal expense assessed against each department. This normal expense, it will be recalled, was the original basis on which the machines were assessed with their proportion of expense loading, which was later on reduced to a machine hour rate.

It does not necessarily follow that because a variation exists between the machine earnings of any one department and the current expenses of that department, for any month, six months, or year, when such comparison is made, that the loading rates are wrong. I called attention to this point in an earlier chapter and pointed out the fact that even a period of a year may be too small a cycle on which to establish normal shop expenses. It should be kept in mind, however, that, that when extreme variations appear, the cause should be immediately investigated, and if it is found that an error of omission or judgment has been made in establishing the normal figures, an adjustment should immediately be made in the machine rates of the department in which the error is found.

Therefore, while the monthly comparisons of machine earnings and current expenses of any one department of the factory do not serve as a test of the correctness of the machine rates in that department,

they do, nevertheless, show the trend of affairs; and when a variation is very marked, special attention can be given in the following months to such departments in which differences appear. If, then, after several months of close supervision over any abnormal differences, the machine rates appear to be too low, an adjustment can be made without waiting until the end of the year.

It should be constantly borne in mind that adjustments of this nature in the expense loading rates are to be made only in extreme cases, and after the most thorough investigation has conclusively proven that an error has been made. A change in rates, even when made in only one department during the course of any year, will cause considerable confusion and necessitate the changing of all cost data affected thereby for preceding months. It is advisable, therefore, to neglect slight differences during any quarter on the assumption that they will be offset during one or more of the ensuing months of the current year.

CHAPTER XXII

CURRENT VARIATION RATIOS AND THE SUPPLEMENTARY RATE

Standard Expense-Loading Rates.—Standard expense-loading rates, whether based on the machine hours, the pound output, or any of the other different units discussed in the preceding chapter, are computed from and represent the ratio of "Normal Expense" to "Normal Units." It is evident that a long-continued use of such rates, derived from a study of shop expense and shop activity for several years past, and from a consideration of what present knowledge would seem to indicate as to future conditions, will produce as nearly as possible, an amount of expense loading equal to, or closely approaching, the shop expense of any one normal year.

Costs based on such rates would be average costs, and would be neither high nor low under average conditions. They would therefore be costs on which it would be safe to base average selling prices. There are, however, certain factors that continually tend to cause fluctuations in these normal figures, or even to cause their entire revision. A few of these are the following:

(a) Changes in speed, method of operation, or in the physical condition of the machines.

(b) Changes in distribution of the idle machine

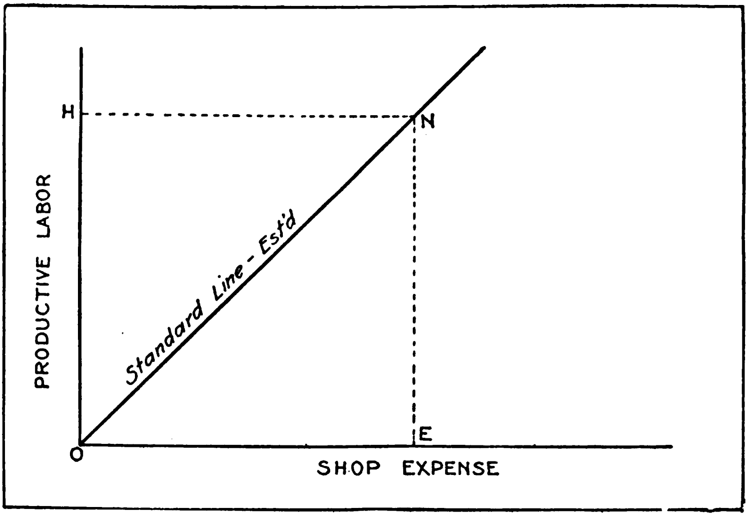
time among the various types, caused by changes in methods of manufacture, changes in kind of output and so on.

(c) Changes in the relative prices of various supplies, expense labor, and other kinds of expense which are applicable against machine expense.

Relation of Expense to Units.—But it is evident that as time goes on and revisions and studies are periodically made of these factors that are conducive to variations between the actual and the estimated shop expenses, changes will become less necessary, and eventually estimates can be made in advance which will closely approximate the ultimate expense figures. In order to indicate the relationship existing between the shop expense and the units which are used as a measure of shop activity, I shall take for example a typical illustration wherein the productive labor is used as the unit whereby to measure this activity.

Since we assume that the relation of expense to units is a fixed relation, then if we were to plot on co-ordinate paper the point for normal expense as abscissae, and the point for the normal units (productive labor) as ordinates, and draw perpendiculars from both of these points to their intersection, we could draw a straight line passing through the origin and the intersection of these two lines, whose slope would be equal to the anti-cotangent of the angle formed by their intersection. Such a line let us call the "Standard-Expense Line." Now if the expenses of operating a shop varied directly according to its activity, then this standard-expense line would be indicative

of the amount of expense assessable against the output of the shop for any degree of shop activity. For example, if we plot the normal productive labor point at H and the normal expense at E (see accompany-



ing chart), then if we draw the "Standard Line Est'd" through the intersection of the lines HN and EN at the normal point N, this standard-expense line will theoretically be indicative of the amount of shop expense for any point on the line O H where a line parallel to H N intersects the "Standard Line Est'd."

Reason for Change in Ratio of Expense to Units.— However, if this were actually true, then if the activity of the shop should fall to the zero point (O), the shop expense would also be zero. In other words, if the shop shut down completely, no expense would

be incurred. A moment's reflection will however convince the reader of the absurdity of such a condition, for the reason that there are certain fixed expenses that still go on, even when a factory is entirely shut down. For example, depreciation, insurance, and taxes go on, irrespective of fluctuations in shop activity; watchmen's salaries and fire-protection expenses must still be carried, as well as many other incidental costs; for example, those of keeping the machinery oiled and of making such repairs as even a vacant building requires, are incurred even when the factory building and its equipment are not being used.

Then—considering this same question from the viewpoint of low activity—when the factory is still being used, but only to a small extent of its full productive capacity, the expenses are still greater. Periods of depression do not usually occur overnight. They come about through a gradual diminishing of orders, and often extend over a considerable period of time. It is no uncommon thing to find a shop working at only 25 per cent of its normal activity, and still maintaining its full clerical and supervisory force, its normal engine-room and service help, and many other sources of expense, simply because conditions were expected to improve at any moment, or because the management did not fully appreciate the tremendous burden that the profits would have to sustain on a reduced volume of sales.

Such a condition represents the dangerous factor of shop management—the inability of most managers to appreciate the relationship between their expense

burden and their output. It is the shoal on which many prosperous-appearing industrial enterprises have gone to pieces merely because those responsible for their success have failed to appreciate this fundamental principle of shop management: namely, that costs of production increase as the activity of the shop decreases.

Effect of Constant Expense on Low-Activity Costs.—It will be seen, therefore, that one of the first things to be looked into by the management, is the relation existing between the constant and the variable expenses of the shop at different degrees of activity. During the latter part of the year 1908, when the full force of the panic of the preceding year was beginning to manifest itself with telling effect on the manufacturing industries of the country, the shop superintendent of a plant located in the vicinity of New York confronted me with the following question: "How low can I let the activity of my shop run, before I will be operating it at a loss?" In other words, this executive had begun to realize the fact that his shop's expenses consisted of two kinds, one over which he could exercise control, and another over which he had very little control, or none whatever. He saw that there was a point somewhere on his shop's scale of activity at which his expenses would be greater than the profit that the company made on the goods produced, and that consequently a direct financial loss would be incurred for each article produced. This discussion leads us to a consideration of the two kinds of shop expense that cause such a condition of abnormal production costs.

Constant and Variable Shop Expenses Defined.—"Constant Expense" may be defined as that part of shop expense which is neither dependent on, nor affected by existing shop conditions, which will remain constant irrespective of the fluctuations of shop activity, and which is comprised of items of expense incidental to the general upkeep of the plant.

"Variable Expense" is that expense which is incurred directly through manufacturing activity, and which varies in almost a direct ratio with the increase or decrease in such activity. It is made up of all shop expenses which are not considered constant, and which cease to exist when the shop is shut down.

In order, therefore, that the relationship may be established between the expense burden as it would appear under normal and abnormal conditions, respectively, a point must first be established which would be indicative of the amount of shop expense that would be incurred even were the shop to be shut down.

"Current Variation" Defined.—Hence, if we draw a line, the origin of which is at the "Constant-Expense point (X), and which passes through the "normal point (N), this line would be indicative of the amount of normal shop expense for any degree of shop activity. This line (X N) is called the "Current Expense" line, and the difference between this line and the "Standard" line, at any degree of shop activity, is the measure of the error between the applied and the actual shop expense for that degree of activity. This difference is called the current vari-

ation. If it is below the normal point, it means that the amount of expense burden being added to current costs is not equal to the normal expense for that degree of shop activity. Hence the current costs must be adjusted by adding a sufficient amount of expense loading to wipe out this variation. This amount is determined by computing the ratio of the current variation to the predetermined standard expense already applied to costs, expressed in terms of percentage of the standard expense as represented by the "Line Est'd." This percentage is then added to all costs of work done during the specific period for which the correction is made; in this way the excess expense is absorbed by the output for that period.

Effect of High Activity on Shop Costs.—If the degree of shop activity is above the normal point, then the current variation becomes a minus instead of a plus quantity, and the adjustment in current costs is made by subtracting, instead of adding, the difference between the "Standard Line Est'd" and the "Current Line Ecur." It should be thoroughly understood that this "Current Line Ecur" does not represent the actual current expenses of the shop, but the amount of expense which a study of past and present experience, together with ample allowances for the future, would seem to indicate as being normal for that particular degree of shop activity. No adjustments should be made to correct differences between the actual current expense and the normal expense as indicated by the line "Ecur," except at the end of a year, or when a radical error seems to

have been made in estimating the expense loadings. The reason for this is that the current expenses may contain items that should be charged over the whole year, and not in any one month or quarter. Therefore, the adjustment made at any time during a fiscal year is measured simply by the difference between the lines "Est'd" and "Ecur," expressed in the form of a percentage of the expense loading already applied.

Reason for Standard Costs.—The reader may possibly raise a question as to the reason for making these adjustments for current variations. He may ask why the expense loading first applied as a part of the cost of the shop's output for any month or quarter year, should not be the normal expense as expressed by the "Current Line Ecur" for that specific degree of shop activity, instead of that indicated by the standard expense line "Est'd." The reason will be clear if it is remembered that shop costs are being compiled and computed as the various jobs or orders worked on are completed, and that inasmuch as the activity of the shop for any period cannot, in most cases, be accurately predetermined, it is impossible correctly to determine the true normal expense until the particular term has elapsed.

Furthermore, for purposes of executive control, all costs should first be compiled on the same basis, in order that comparisons may be made between the costs of different periods. It would not be practicable to keep adjusting the machine-hour rate on every machine tool each month or quarter, so that these rates would absorb all of the current normal

expenses, first, because of the tremendous volume of clerical work that would be necessary, and secondly, on account of the fact that if this were done the basis of comparative costs would be removed, and the management would be left with no means whereby to control abnormal costs of production.

Importance of Cost Analysis.—For example, the cost of work done on a machine with a rate of 20 cents an hour, would always first be figured at the 20-cent expense-loading rate, irrespective of whether the work was done in January or in September. This cost would then be corrected by adding or subtracting the current variation for each particular month. In January, the cost of producing 5000 pieces on a machine with a rate of 20 cents an hour might be this:

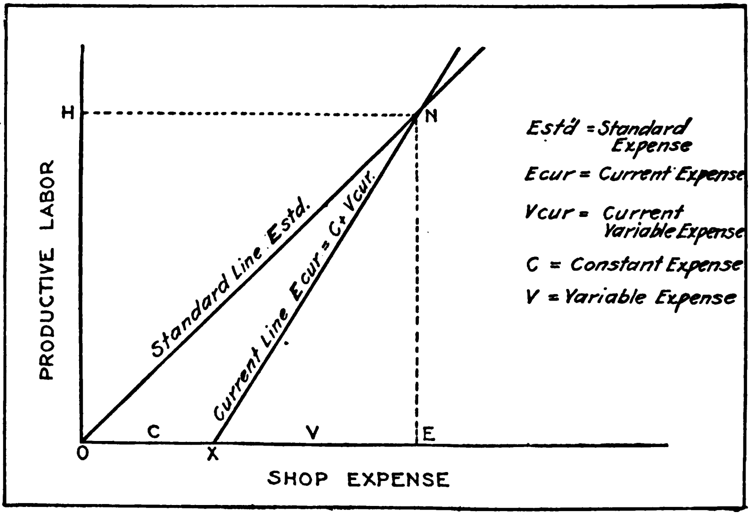
Productive Labor....................	$ 75.00
Raw Material........................	40.00
Expense Loading	
90 Hours @ 20 cents..............	18.00
Standard or Basic Cost..............	$133.00
Current Variation =	
+ 10 per cent of Expense Loading	1.80
Current Cost........................	$134.80

In September, however, the cost of this same quantity might be only $126.80. This we see from the following cost summary is due to the fact that the actual labor hours were less than in the month of January and hence the labor cost and expense loading were also less.

Productive Labor....................	$ 70.00
Raw Material.......................	40.00
Expense Loading	
84 Hours @ 20 cents..............	16.80
Standard or Basic Cost..............	$126.80
Current Variation =	
+ 50 per cent of Expense Loading	8.40
Current Cost.......................	$135.20

A study of these two cost analysis will show that in January the basic cost of this work was $133, as compared with $126.80 in September. In other words, the figures show that the job was actually done at a smaller basic cost in September than in January. However, the current variation in January was only plus 10 per cent, while in September it was plus 50 per cent, so that the total cost for September was more than that of January. This difference was evidently due to the fact that the shop as a whole was working at a lower degree of activity in September than in January. This is made clear by the accompanying diagram, which shows a greater variation between the Standard and the Current Expense lines as the degree of activity diminishes.

The reason for first computing costs on the basis of the standard-expense loading rates will therefore become apparent, since without such a basis of comparison, the management would be unable to control the shop efficiency. In the examples that I have just used, the current cost for September, if no such analysis were made, would seem to indicate inefficiency on the part of the workman, while it actually shows, on analysis, increased efficiency on his part.



Placing Responsibility for Abnormal Costs.—The management must therefore look for the remedy, not in the shop proper but to other sources. Two of these sources may be the sales department and the general management—the former may not be keeping the shop busy with orders; the latter, by diverting part of the orders to sub-contractors or to other shops of the company, may be responsible for the depression in the activity of the local shop. However, whatever the cause for the lessening activity may be, it is of paramount importance to be able to differentiate between increased costs due to inefficiency of production, and costs which are higher because of a low degree of shop activity. The necessary information together with the true current costs, can be obtained only through a cost analysis similar to that

which I have made to illustrate the point under discussion.

Some writers take the viewpoint that the current variation as expressed by the supplementary rate, is a measure of the efficiency of the shop management. That this is not so, can be easily proved by comparing the costs for January and September in the example which I have just used. The supplementary rate is a measure of the efficiency of the general management of the business as a whole, but it is not a measure of solely the shop efficiency.

Shop costs may rise, as we have seen, when actual savings have been made by the workman or the foreman, but in such cases as this one they can usually be traced to sources outside the manufacturing departments. On the other hand, a decrease in cost may occur even if the shop has expended more time and material on certain work than was formerly the case. Such a reduction can be explained by an analysis of the cost figures, which will undoubtedly show a lower supplementary loading rate for former work. The real benefits to be derived must therefore come from a study of the basic cost figures, rather than from the supplementary rate or the current costs.

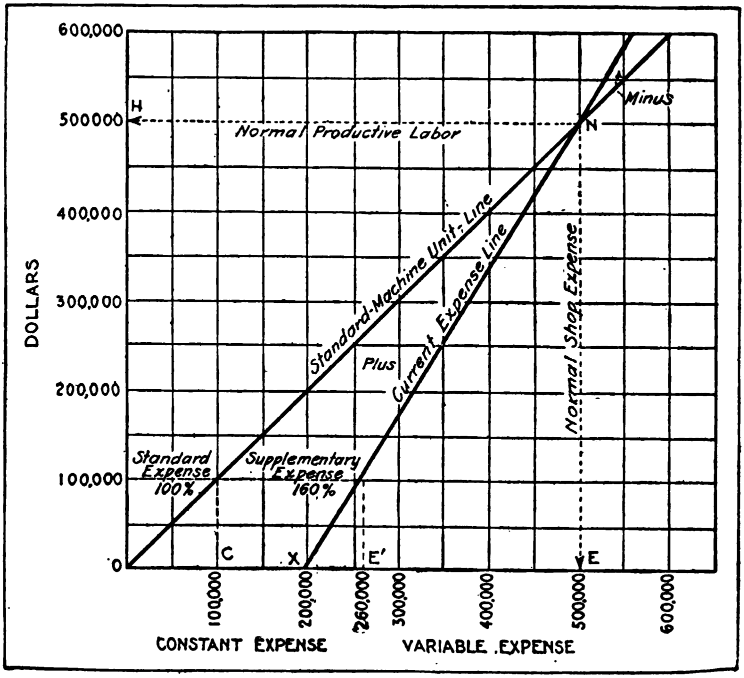
Necessity for Knowing Actual Current Costs.—While the basic cost figures form the true basis of shop efficiency, it is nevertheless extremely important for the general management of the business to know the real current costs which include the supplementary expense loading. Work is sometimes done on the basis of "cost plus a percentage for profit" basis,

and in billing it would therefore be essential to know the real cost. This real, or current, cost must necessarily include its just proportion of the normal operating expenses for that period—hence the reason for incorporating the supplementary rate as a part of the shop cost of goods manufactured on this basis.

However, the short-sightedness of this policy will become evident when it is discovered that costs will gradually become prohibitive as production falls off, with the result that instead of quotations for prospective work being low when such work is needed most, they will be so high that no orders can be booked. Without attempting to discuss at this point the justice of loading on to the shop all of this excess burden which is caused by low activity, and over which it has no control, I simply want to call attention to the direct effect on a manufacturing business of such a condition as the one here described.

Establishing the Changing Ratios.—Let us assume, for example, the case of a factory which has a normal productive labor payroll of $500,000 a year, and in which a study of the shop expenses shows that they, too, amount to approximately $500,000 a year under normal conditions. A further analysis of the expense figures shows that $200,000 is fixed or constant; the rest is variable, the amount depending on the governing degree of shop activity. Then, if we plot these figures on cross-section paper, the productive labor as a measure of activity being plotted as ordinate and the expense as abscissae, the amount of the supplementary loading against the shop can be easily

ascertained for any degree of activity. As each square represents $50,000, the approximate equivalent amount in dollars is shown as increasing in a fixed ratio as the activity falls below the normal point (N), and decreasing in the same ratio as it goes above it.



RELATION OF NORMAL CURRENT EXPENSE TO ACTIVITY

A study of the table on page 463 will show that while the normal point shows the expense to be 100 per cent of the labor, it is nevertheless the only point at which it is 100 per cent. When the activity falls below normal, the expense goes up to as high as 260

per cent of the productive labor as indicated at the $100,000-activity point, and even higher when the activity falls still lower. On the other hand, the expense correspondingly falls to less than 100 per cent of the productive labor when the activity goes above normal. A study of the figures contained in this table will clearly show this relationship between the shop expense and productive labor at different degrees of activity.

Method of Compiling Expense Table.—A table of the kind just referred to will indicate the approximate normal expense for different degrees of shop activity, can be compiled for any factory by prorating the difference between the constant and the normal shop expenses, over intermediate points of activity. For example, in the case under consideration, the normal shop expense is $500,000, and the constant expense is $200,000; therefore the difference, $300,000, which is the variable expense, must be prorated between the point of no activity (O) and that of normal activity (N). At the half-way point (50 per cent activity), which is represented by $250,000 of productive labor, the normal expense would be $200,000 + (50% of $300.000)—in other words, $350,000. Therefore, if we establish periodic points of activity, as has been done on the accompanying table, at intervals represented by $20,000 of productive labor, the proper proportion of the variable expense incurred by each point of activity can be easily determined, and then by adding the contant expense for specific degrees of activity, the normal expense for that degree can easily be established.

Deflection of the Current-Expense Line.—For purposes of comparison, I have plotted the variable expense as a straight line between the points of no activity and normal activity respectively. It does

Productive Labor (Normal Point at $500,000)	Actual Shop Expense (Constant Expense $200,000)	Estimated Shop Expense Applied to Current Costs by Machine Unit System	Current Variation to be Added to or Subtracted from Current Costs	Per Cent Actual Expense of Applied Expense	Per Cent of Expense Applied, which is to be Added to or Subtracted from Current Costs
$ 20,000	$212,000	$ 20,000	add $192,000	1060	add 960
40,000	224,000	40,000	" 184,000	560	" 460
60,000	236,000	60,000	" 176,000	393	" 293
80,000	248,000	80,000	" 168,000	310	" 210
100,000	260,000	100,000	" 160,000	260	" 160
120,000	272,000	120,000	" 152,000	227	" 127
140,000	284,000	140,000	" 144,000	203	" 103
160,000	296,000	160,000	" 136,000	185	" 85
180,000	308,000	180,000	" 128,000	171	" 71
200,000	320,000	200,000	" 120,000	160	" 60
220,000	332,000	220,000	" 112,000	151	" 51
240,000	344,000	240,000	" 104,000	143	" 43
260,000	356,000	260,000	" 96,000	137	" 37
280,000	368,000	280,000	" 88,000	131	" 31
300,000	380,000	300,000	" 80,000	127	" 27
320,000	392,000	320,000	" 72,000	123	" 23
340,000	404,000	340,000	" 64,000	119	" 19
360,000	416,000	360,000	" 56,000	116	" 16
380,000	428,000	380,000	" 48,000	113	" 13
400,000	440,000	400,000	" 40,000	110	" 10
420,000	452,000	420,000	" 32,000	108	" 8
440,000	464,000	440,000	" 24,000	105	" 5
460,000	476,000	460,000	" 16,000	103	" 3
480,000	488,000	480,000	" 8,000	102	" 2
$500,000	$500,000	$500,000	......	100	Normal
$520,000	$512,000	$520,000	deduct $8,000	98	deduct 2
540,000	524,000	540.000	" 16,000	97	" 3
560,000	536,000	560,000	" 24,000	95	" 5
580,000	548,000	580,000	" 32,000	94	" 6
600,000	560,000	600,000	" 40,000	93	" 7
620,000	572,000	620,000	" 48,000	92	" 8
640,000	584,000	640,000	" 56,000	91	" 9
660,000	596,000	660,000	" 64,000	90	" 10
680,000	608,000	680,000	" 72,000	89	" 11
700,000	620,000	700,000	" 80,000	88	" 12

not necessarily follow, however, that the variable expense will vary directly as the activity of the shop increases. There may be certain controlling factors, such as the employment of larger power generators

as the activity increases, which, because of proportionately lower operating charges per unit of power generated, may tend to change this variable-expense line from a straight line to a curve. Such factors as these must all be carefully considered when the expense figures are being compiled, but in the average manufacturing establishment it is usually safe to consider that this variable expense varies practically in a direct ratio to the increase in activity of the plant.

After the activity for any month is known, reference can be made to a table of this kind, in order to determine the amount of expense which must be either added to or subtracted from that applied during that month as a part of the current costs of production. The table provides a ready means of determining the exact percentage that will be used in making the adjustment, and eliminates all such complexities as would occur if logarithmic tables or algebraic formulas were resorted to.

For example, if it were found, after the end of a month, that the current activity of the shop, expressed in terms of productive labor, has amounted to $460,000, the reference table would indicate that the normal expense for that degree of activity was $476,000, making a minus variation of $16,000. As the expense applied during the month to costs amounted to 100 per cent of the productive labor, or $460,000, then the percentage that will have to be added to each job-cost sheet amounts to approximately 3 per cent of the expense already applied through the machine-hour rates or other units of distribution.

Use of Other Units of Activity.—While I have considered the normal shop expense in the various illustrations used in this chapter, to be equivalent to 100 per cent of the productive labor, the same principles and methods would apply if the expense were greater or less than 100 per cent. For the sake of simplicity, I have also used the productive labor as a measure of shop activity, although very often, especially when this productive labor consists of a combination of day-work and piece-work, the actual man hours would form a much better basis. However, the reader will understand that each of these factors must be dealt with separately in each plant.

I have endeavored to point out, in this chapter, what I consider to be the most important phase of industrial cost-finding. The fact that the indirect expenses of any factory vary so greatly with its activity, should immediately focus the attention of all executives on this factor in order that the proper precautionary measures may be taken to safeguard the output of the plant against prohibitive costs.

CHAPTER XXIII

EXECUTIVE CONTROL OVER PRODUCTION COSTS

Limit of Executive Control.—It should be evident to any one who has carefully studied the analyses of constant and variable shop expenses which have been made in the preceding chapter, that as the activity of a shop decreases more and more, the greater must be the executive control over such expenses. Moreover, it is evident that there is a limit to the extent to which such executive control, through a reduction of current expenses, can effect any appreciable reduction in current costs. This limitation, we have found out, is due to the fact that the constant expenses of the shop become, at a certain point, the major portion of the entire expenses incurred during that period. Therefore, when this point is reached the management is confronted with one of two alternatives: Either it must close down the factory, or it must look about for some kind of work, which, while it may not be directly in line with what the factory has previously done, can nevertheless be managed with the equipment at hand, and which will therefore help to raise the activity of the shop to the normal point or to some point of activity closely approximating it.

Price-Setting at Low Activity.—The price at which such work would be taken is a factor of the greatest importance. We have seen that costs, when figured at a point of low activity, are very high as compared with costs when figured under normal conditions. Therefore, if estimates are made for work of the nature just referred to, and are figured as of the existing degree of shop activity, it will stand to reason that such estimates will be prohibitive on their face, and that orders for work of this kind will not be procurable.

If, on the other hand, we absolutely neglect the consideration of existing conditions, and furnish estimates for such work as figured at the normal activity of a factory, the possibility of securing such work will be considerably enhanced. Consequently, the question of profit comes up at this point. When a period of depression exists in manufacturing, it is not only extremely difficult to secure orders for any kind of work at all, but it is almost impossible to secure such work at what would be considered, under normal conditions, a fair profit. The question naturally arises, then, whether it would not be good policy to take on such work at absolute cost, without any profit, providing such cost includes only the normal amount of expense loading, as figured at the normal point.

Effect of Price-Setting.—Let us consider this question for a moment, and see how it would affect conditions in a specific instance. Let us assume that in the plant considered in the preceding chapter—which has a productive labor payroll of $500,000 in

a normal year—this productive labor, which is indicative of shop activity, drops to an activity basis of $100,000 a year. Referring to the table on page 463, we find that the shop expense for that specific degree of shop activity, instead of being 100 per cent of the productive labor, or $100,000, is actually $260,000, or 260 per cent of the productive labor. Therefore, a shop cost compiled under the existing conditions with an expense loading of 260 per cent of the productive labor, would probably be so high that it would be poor business to carry on production under such conditions.

Let us assume that a cost is made up, under normal conditions, as follows:

Productive Labor....................	$20.00
Shop Expense (100 per cent of Productive Labor)....................	20.00
Material	10.00
Total Shop Cost....................	$50.00

If we figure this same job, however at the $100,000-activity point, the cost would then be $82, made up as follows:

Productive Labor....................	$20.00
Shop Expense (100 per cent of Productive Labor)....................	20.00
Material	10.00
Standard Cost......................	$50.00
Current Variation (160 per cent of Expense)	32.00
Total Shop Cost....................	$82.00

If we further assume that under normal conditions 50 per cent was added to the shop cost, to cover general expense and profit, then the selling price of this article would be $75. However, we find that $82 is its actual cost of manufacture under the existing conditions of lessened shop activity, which is considerably more than the ultimate consumer will pay. In such a case, therefore, the management must decide whether manufacturing is to be discontinued, or whether some remedy that will improve this condition can be instituted.

Prices Based on Normal Costs.—Now let us see what would happen if the management decided to do work on a normal cost basis without any profit. Let us assume that it secures enough work to represent $500,000—that is, enough to raise the activity of the shop up to the normal point. Then, while no profit would be made on any of this outside work, the above order, instead of having a prohibitive expense loading of 260 per cent, would have only the normal expense loading of 100 per cent, which would bring the cost of manufacture again down to $50, and, by so doing, enable the manufacturer to market his goods without loss.

In other words, we find that by means of the simple expedient of raising the activity of a shop, costs can be reduced on the standard output of the factory, even if—as in the case here cited—this standard output amounts to only 20 per cent of the entire work being done in the factory. It is also obvious that in times of depression it may be necessary to reduce the profit normally made on the stand-

ard output of the factory, and this, we see, possibly can be done by reducing the selling price from $75 to $65. Such a reduction would in all probability enable the manufacturer to market his product at a price which, while it netted him only a bare margin of profit, would nevertheless keep his organization intact, and permit of his gaining considerable advantage over his competitors by virtue of this fact, when conditions again reached normal.

The Principle Applied.—I recall a case that will serve as a concrete illustration of how this principle may be applied to actual manufacturing. The plant that I have in mind employed very nearly 10,000 people under normal conditions, and was engaged in a line of manufacture which was of an extremely technical nature. The organization that this company had perfected, had taken many years to build up, and the loss which it would have sustained through having to disrupt it would have made it almost impossible to resume business again under anything like the previous conditions. They manufactured electrical goods, and their equipment contained a large percentage of special apparatus that could be used only in the particular class of manufacture in which the company was engaged. It is a matter of record, however, that in spite of this handicap the company took on contracts for grinding safety-razor blades, at a price fixed at absolute cost as figured at the normal point, and, with other work of a similar nature, not only was able to operate its plant at an increased activity, but actually succeeded in bringing it up to the normal operating standard. The re-

sult was that when conditions improved, the company had such a big lead over its competitors who had not recognized this fundamental principle of management, that it was able practically to monopolize the entire field, in which it has never been supplanted as the greatest producer of that particular class of merchandise. This is just a specific illustration of the practical application of a simple principle, but the application of the principle was nevertheless the direct cause of saving many hundreds of thousands of dollars.

Introducing a Remedy for Low Activity.—Still another instance of the application of this principle is to be found in the case of a comb factory located in northern New England, in a town where there are some thirty similar factories, and where a keen sense of competition continually exists in connection with the securing of the necessary factory help. Several years ago, it was my fortune to be working in a consulting capacity for one of the largest of these plants, at a time when a period of depression was just setting in. Considerable discontent was manifest on the part of the operatives, most of whom were women, over the fact that practically all these plants were discharging employees right and left, and furthermore, because the line of manufacture by which they earned their livelihood was of such a specialized nature that they were practically unfit for any other kind of work, and consequently faced hardship. It happened that in addition to the regular comb-making departments which were regularly used in the standard production of this plant, there was also a

large wood-working department. This was used for making the comb shapes, and for doing miscellaneous jobbing work secured from other comb factories, which did not have such an adjunct to their plants.

The company which I have referred to was controlled by two partners, one of whom was a practical comb-maker who had been in the business for over fifty years, and who looked after the entire manufacturing end of the business. The other, who was a considerably younger man, about forty years old, concerned himself chiefly with the sales and the financial end of the business. Realizing the condition which would shortly exist in this industry, I called both these men into a conference, carefully explained to them the principle of expense distribution which has been discussed in this and the preceding chapter and suggested a plan of action. I was able to convince only the younger man, however, whose knowledge of the actual manufacturing work was considerably limited.

My suggestion was that the company look around for some class of work that they could do in either the main part of the factory or in the wood-working shop, which would enable it to keep up its activity and, by so doing, hold together its force of employees and thereby gain considerable advantage over their competitors when normal conditions were again resumed. The older and more practical man claimed that such methods were simply "new fangled" notions, and that his experience of many years in the comb-making business had conclusively proved to him that slack periods had to be accepted as a mat-

ter of course. He finally gave way, however, in the face of strenuous opposition, and shifted the responsibility for whatever action might be taken, to the younger partner and myself.

Benefits Derived from Contract Orders.—After considerable work with pencil and paper, we were finally able to reduce the entire problem down to that of securing work for the wood-working section of the plant, with possibly some co-operative use of the other departments. A systematic campaign was then begun, to find some kind of work that could be done at absolute cost, with the result that a large order was secured for a toilet specialty, celluloid-backed brushes which consisted of celluloid mounted on a base form of wood. The manufacturer from whom the contract was secured, was actually contemplating closing his plant, because his costs, as he figured them, would be prohibitive if he continued operating under the existing conditions. Data which he furnished me made it clear to me why he was not successful, in view of the fact that his cost system did not give him anything approximating exact cost figures.

The result was that this work was secured by the comb-making plant at a price which was considerably lower even than the manufacturer's normal costs; he was therefore very glad to accept the proposition made to him. The result of this piece of strategy, if it may be called such, was that the comb-making plant was able to operate at about 75 per cent of its normal activity, and, as later events proved, was in a much better financial and operating condition when

activity in its regular line was again resumed, than any of its competitors. As a sequel to this incident, it might be stated that I made an appraisal of the property at the suggestion of the older partner, and, on the basis of the valuation so arrived at, he sold out his interest in the business to the younger partner —not, however, before frankly admitting that the new methods were right and that he was too old to be taught all over again.

Charging the General Management with Shop Overhead.—While the foregoing illustrations serve to indicate how to control rising expenses due to periods of depression, there is still another point which is worthy of the most careful consideration. Under the existing conditions, the shop management is charged with all of these increased expenses of operating the shop, which are due to conditions over which they have no control; but the general management of the business is able to shift the entire responsibility from its shoulders to those of the shop executives. While it is easy enough to explain the fact that costs have increased because of an abnormal drop in activity, it is not, on the other hand, so easy to differentiate between costs that have increased only slightly, because of only slight drops in activity.

For example, if a shop were operating at, say, 90 per cent of its normal activity, the general management in the average plant would point to the increase in shop costs that was due to this decrease in activity, and claim that the shop administration was directly responsible for such an increase. In other words, they would not take into consideration at all,

the slight decrease in activity, moreover, in the majority of cases, the shop management, not fully understanding the real cause of the increase in costs, would accept the blame without being able to make any explanation. If the fault lies with the sales branch of the company, because of its inability to keep the shop busy, this department should be charged with the additional expense, and not the shop. If, on the other hand, the general management is responsible, because of some policy which it has put in force, then it should be charged with the increase, and not the shop.

Expediency No Excuse for Errors in Cost Accounting.—A. Hamilton Church, in his book on "Expense Burden," says, "We are obliged, from motives of expediency, to look upon idle time as a kind of visitation of Providence which the whole shop ought to bear." If this is true, then the shop should most assuredly be charged with every expense which it is possible to load against it. On the other hand, it has been my experience that the general management of most manufacturing plants finds such "visitations of Providence" a most useful medium for shifting its own responsibility. In any event, if we charge Providence with the expense of such idleness, is there any reason why the shop proper should bear all of this expense to the exclusion of the general and sales branches of the business?

Proportioning Overhead Charges on Basis of Control Exercised.—If we analyze this matter very carefully, we must find that it is not fair to charge any branch of the business with any expense over which

it has no control. The shop is left with no means of securing additional work to keep it busy when it finds its activity falling off; therefore, there is no reason why it should be charged with any expense except that which it actually incurs in carrying on the specific production in which it is then engaged. If a shop has an excessive amount of floor space, the resulting expense would not ordinarily be assessed as a burden on the shop. If a manufacturing company has three plants and shuts down two of them, it would not ordinarily charge the active one with the upkeep of the two idle ones, and include all of this extra expense as a part of the cost of production in the plant being operated. And yet, does not this same condition exist if we consider each machine as a separate shop, paying for its own rent, depreciation, administration, taxes, tools, and so on? This is precisely what is done when we distribute the shop expense through the machine-hour rates.

Putting It Up to the Management.—It has been the policy for many years in most manufacturing plants to allow the general management of the business to escape scot free from any blame incidental to increased cost that is due to a depression of activity. The explanation that costs are high because of poor markets, has been accepted by the directors of these manufacturing companies as indicating something beyond their control. The general management has therefore escaped all blame, while the shop management has very often had great difficulty in explaining its rising costs. If, to use a modern expression, the general management had been "on the job," in all

probability it could have instituted the necessary remedies, similar to those which I have described in this chapter, and, by so doing, could have placed the company in a sound financial and producing condition. In other words, up to a short time ago no method had been inaugurated whereby the efficiency of the general management of the company could be measured as accurately as the efficiency of the shop management. It is reasonable to assume that when such a control as this is exercised over all branches of a manufacturing business, the loss resulting from bankruptcy and other causes will be greatly reduced.

General Management Efficiency Account.—If we can show, by means of some account, the efficiency of the general management, simply by charging the shop with the costs of that part of a plant which it is actually using at any time, then some means will have been provided whereby the efficiency of the general management can be measured. At the present time, we charge the shop with the shortcomings of the sales and the general management branches of the company, when, as a matter of fact, "the expense chargeable against the shop should be only that portion of the constant expense which the current activity is of the normal activity, plus the actual variable expense." In other words, we find that the reason why costs increase as activity decreases, is that the shop is obliged to bear all the constant expense, whereas it should bear only that portion of the constant expense which it actually incurs in production. For example, if the activity of a shop for a certain year were found to be 60 per cent of the

normal activity, then the expense chargeable against the shop for that year should be only 60 per cent of the constant expense, plus the actual variable expense incurred during that period. The difference of 40 per cent of the constant expense should be charged to the general management of the business—to explain or remedy, as it chooses.

Crediting the General Management.—While we have been considering cases in which the activity of the shop has been below normal we must also consider cases in which the activity of the shop, because of efficient management, has been raised to above normal. A study of the chart on page 461 will show that as the activity goes above normal, the amount of shop expense per unit of production is less than that applied at the normal point, or at any point below it. This means that because of efficient management, the amount of expense incurred would be less than 100 per cent in the specific case under consideration, and therefore the management should receive some credit for its efforts. This cutting down of the expense is accomplished by loading against the shop the amount of expense shown by the line ONB, which, above the normal point, will be found to be more than the actual shop expense incurred. The general management is credited with the difference between the actual amount of expense, as indicated by the line XNC and the line ONB. That is, the current variation, which, above the normal point, becomes a minus quantity, represents the credit to the management; while below the normal point, the current variation, which is a plus quantity, represents a

debit for the management. Costs that would be so computed at any degree of activity above the normal point, would therefore have an expense loading of 100 per cent, or considerably more than the amount of expense that has actually been incurred by the shop. If this method is used costs will be low when business is most needed, and will be high when conditions are prosperous and business is easily obtainable. Furthermore, shop costs, because they are figured on the same bases as those represented by the straight line ONB, will be comparative at all times, and will reflect the efficiency of the shop administration for different periods.

By this method, the management will also be able to secure credits which will tend to offset debits charged during periods of depression, and if these entries are made in an account called "Management Efficiency," that account will tend to reflect the efficiency of the general management of the company at all times.

Shop Expense Not Necessarily a Measure of Efficiency.—Many manufacturers look upon an increase in shop expense for a comparative period of activity as being indicative of inefficient shop management, even though an actual analysis of conditions may show that the opposite is true. The rapid development of automatic machinery has introduced an element in the form of increased expense with lower labor costs. Whereas formerly a great deal of manufacturing was done by manual labor, this has now been superseded by automatic machinery, the operation of which entails considerable expense. For ex-

ample, screws were originally turned by hand; then pin machines were developed, by which the turned parts which had been cut to size were threaded automatically; later, the operations of turning and threading were done, simultaneously, on a rod which had been cut to the correct length. Finally, improvement was carried to the point where drilling, tapping, and slotting were added. Each of these stages of development reduced the amount of manual labor but, on the other hand, increased the expense of operation.

Therefore, if we were measuring the amount of expense incurred at any time, by figuring it as a percentage of the productive labor, we should bear in mind the fact that a decrease in the productive labor caused by the introduction of such automatic machinery would make the expense higher and the percentage of expense to labor considerably greater, since the labor had been reduced and the expense increased. A cost analysis, however, might show that the expense had not been increased as much as the labor had been decreased, and hence the total cost of production would be considerably less than previously. At the same time, while such an analysis would unquestionably reflect efficiency on the part of the shop management, a comparison of only the expense for the different terms of manufacture would reveal quite the opposite condition. It therefore stands to reason that an increase in expense does not necessarily indicate inefficiency on the part of the shop management, except in instances in which no improvements—like the installation of the automatic

machines, for example—have been made, and in which the same methods of production exist year in and year out. This is a very vital point, from a management point of view. Therefore, whenever expenses have been found to increase considerably, it should not be assumed without investigation that such increases are due to lax management of the shop. A careful analysis must be made in order to determine whether or not the productive labor has proportionately decreased, and whether the total costs of production are higher or lower than they were during other periods.

Lower Production Costs Through Increased Overhead.—Such shop expense as that incurred in the modern scientifically managed plant—which includes the cost of maintaining planning and routing departments and statistical corps, making time-studies, and all the other activities conducive to scientific shop-management—is a necessary adjunct, and should really no longer be classified as "expense" in the strict sense of the word. Manufacturers often consider the terms "waste" and "expense" as synonymous, and look upon an increase in expense as just so much waste. That this is not true will be readily evident upon careful analysis of the factors as I have described them in this chapter, and the sooner this viewpoint is eliminated, the sooner will better executive control be made possible.

Importance of Current Variation Principle.—Before concluding this subject of current variations, I want to call attention again to the fact that its fundamental principle is not adequately understood by the

average manufacturer, and that much good work can be done in the way of educating those in charge of plants along the lines herein laid down. Without question it is the most vital factor in shop management today, and offers the means of ultimately steering a business to success, instead of wrecking it on the rocks of ignorance.

If it were necessary for me today to select for emphasis one phase of scientific management to the exclusion of all others, my selection would immediately be that of the relationship of expense to production activity. For if this is not clearly understood, all the benefits accruing from the application of other worthy scientific principles can be so quickly offset that their application will prove useless. On the other hand, a comprehensive knowledge of this phase of management and the embodiment of that knowledge in the methods adopted, will make possible increased efficiency and additional improvement that would not be possible under other methods, even though they may be conducive to lower production costs.

CHAPTER XXIV

COST SUMMARIES

Monthly Cost Summary.—Shop costs should be summarized at least once a month. The cost data for each job or order should be collected and posted on separate cost-summary sheets; these sheets, after all the postings have been made, should contain a complete analysis of the work done. This analysis should include the charges for material used, labor costs, and shop expense loadings assessed against the order.

The material cost is obtained from the store-room requisitions, the labor cost from the time-tickets turned in against the job, and the expense loading from either the time-tickets on which have been recorded the machine hours and rate, or from reference lists of the special loadings assessed by each department on any other expense-unit basis. It is important that the cost of all orders be computed at the end of each month, whether they are finished or not. In this way, entries can be made to the "Finished Goods" and "Work in Process" Accounts respectively, and thus it is possible to provide a means of ascertaining the total volume of work done during the month in question.

Cost Sheet Metal Stamping Company.—Form Number 76 is a specimen of a cost-summary sheet used

by a metal stamping company. On the front side provision is made for recording the data pertaining to the material used on the order. This includes the material worked on in the factory, and that purchased in the form of complete parts which are assembled with the worked material as part of the finished merchandise. In this particular factory, this consisted of chafing dishes, percolators, and other articles of a similar nature.

On the reverse side of this form, space is provided for a record of the various operations necessary to produce the article; the labor cost of each operation; the percentage of expense loading; and the actual amount of expense loading assessed against the order. The sheet is large enough—in this case, 10 x 12 inches—for three columns of this data to be recorded. After the material, labor, and expense charges against the order have all been posted, they are then summarized, and the totals are entered in the spaces provided for them at the bottom of the front side. (See Form 76a.)

Cost Sheet: Woolen Mill.—Form Number 77 is a cost-summary form used by a woolen mill. The arrangement is somewhat different from that of the form just described, on account of the different kind of manufacturing work being done. Provision is made for taking into account the shrinkage loss, and for comparing the cost before and after shrinking the cloth. The expense loading is added to both material and labor—a method that differs from that of the stamping plant, in which the loading is added simply on the basis of labor. The general layout of

FORM 76

MONTHLY COST SUMMARY SHEET

ARTICLE ______________________ Article No. ______________

FINISHED WEIGHT ______________________ Date ______________ 191 ____

	MATERIAL											PURCHASED PARTS			
	Part	Description	GROSS			SCRAP			NET						
			Weight	Price	Value	Weight	Price	Value	Weight	Value		Quantity	ARTICLE	Price	Value

		AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT
	Total Material						
	Total Purchased Parts						
	Total Labor						
	Total Expense						
	Total Manufacturing Cost						
	Selling Expense						
	Total Cost						
	Selling Price						
	Profit or Loss						
	% Profit or Loss						

FORM 76. MONTHLY COST SUMMARY SHEET

DETAILED LABOR & EXPENSE COST

OPERATION	Dept.	Labor	% Exp. Load'g	Expense Loading	OPERATION	Dept.	Labor	% Exp. Load'g	Expense Loading	OPERATION	Dept.	Labor	% Exp. Load'g	Expense Loading	

FORM 76A. DETAILED LABOR AND EXPENSE COST. REVERSE OF FORM 76.

MONTHLY COST SUMMARY SHEET

Style No. ____________

	KIND	Pounds	Rate	Value	Rate	Value	Rate	Value	Rate	Value	Rate	Value
	Total Material Cost											

		Labor	Expense	Total	Value	Value	Value	Value	Value	Value
	Material Cost									
	Weaving									
	Mending									
	Total Cost, Weaving Yds.									
	Per Cent. Shrinkage									
	Total Cost, Shrunken Yds.									
	Fulling and Drying									
	Napping									
	Finishing and Packing									
	Manufacturing Cost									
	Selling Expense									
	Total Cost									

FORM 77. MONTHLY COST SUMMARY SHEET

these two forms does not, however, vary to any great extent.

When the cost sheets have all been summarized, they should be carefully examined to see whether they have been correctly classified. The completed orders are then separated from those which are still in process of manufacture, after which totals for each are compiled. These totals should be made up to show not only the total cost of manufacturing finished and unfinished goods, but also the respective charges for labor, material, and expense of which they are composed. These should also be shown separately for each distinctive class of merchandise,

in order that the proper entries may be made not only in the controlling accounts in the general ledger, but also in the subsidiary accounts in the subsidiary ledger.

Reconciling Cost Totals With Expenditures.—After all of these data have been compiled, the respective grand totals for labor, material, and expense should be compared with the totals as shown by the payroll for that period, the material requisition totals, and the expense loading which the work done during the month has to absorb. If it is found after these comparisons have been made, that the various totals do not jibe, the cost sheets must then be checked until the error is discovered. No entries should be made to controlling ledger accounts of the shop until the totals agree. If the error proves a slight one, an adjusting entry can be made in an adjustment account, but at best this is bad practice and should not be resorted to if it is possible to avoid doing so.

Journalizing Cost Totals.—When the totals of the cost sheets are found to agree with the charges as incurred, entries are made crediting the "Finished Goods" and "Work in Process" Accounts, and debiting the Shop Output Account, as I explained in an early chapter of this volume. The various sub-totals for the respective classes of merchandise are then posted to the sub-accounts in the subsidiary ledger; the totals of these sub-accounts must agree absolutely with the entries made to the controlling accounts.

Method of Analyzing Shop Transfers.—The report on pages 490-491 shows the methods of compiling these monthly cost data for both finished goods and work

in process. It will be noted that on this report the shop expense loading has been assessed as two separate loadings, one called "Labor Loading" and the other "Material Loading." It will be recalled that in discussing the machine-unit system I included in the machine-hour rate only that portion of the shop expense which was charged to "Machine Expense," and that I stated in an earlier chapter, that the material expense should be added as a separate loading on the basis of the weight of material used.

In the report now under consideration the labor loading includes only the machine expense, and the material expense is added as a separate loading. This is undoubtedly the best method of assessing the shop expense against individual orders, but it can be successfully used only when those in charge fully understand the principles involved and the benefit to be derived from accurate cost data.

Filing Cost Data.—After all the entries have been made to the controlling accounts at the end of each month, the cost sheets should be filed by order or job numbers. The following month's cost compilations should be made on separate cost sheets—not carried forward on those of the preceding month. The use of separate sheets eliminates the possibility of including the wrong month's totals in the summaries of the following month.

Cost data, entered in books of record, should be supplemented, whenever possible, with reports or graphs which will reflect the relationship existing between the various factors of production. For example, a report showing the percentage of piece-

John Jones Mfg. Co., Inc.

SUMMARY OF REGULAR SHOP TRANSFERS
FOR FISCAL YEAR ENDING NOVEMBER 30, 1916

The amounts in the column headed Total Deliveries are debited the following accounts:			Material Load Per Cent	Shop Deliveries Credited					40 Shop Piece Parts Credited	Total Deliveries
See No	Class	Name		Labor	Labor Expense Loading	Material	Material Expense Loading	Total		
30	001	General Equipment	12½	$115,087.87	$101,687.78	$40,752.63	$9,527.49	$267,055.77	$447,404.66	$714,460.43
	002	Automobile Equipment	12½	164,060.08	187,233.02	241,372.82	75,206.49	667,872.41	917,928.64	1,585,801.05
	003	Line Apparatus	12½	8,752.32	6,704.74	7,219.90	2,537.01	25,213.97	24,932.20	50,146.17
	004	Insulated Cable	1.3	966.68	432.26	259.14	85.64	1,743.72	106.18	1,849.90
	005	Power Machinery	12½	317.47	230.40	21.83	5.47	575.17	288.50	863.67
	006	Accessories	12½	1.89	4.50	.02	.12	6.53	.50	7.03
Work in Process	007	Fan Motors	12½	40.42	22.42	.11	.02	62.97	43.93	106.90
	008	Batteries	12½	69.09	53.11	110.99	29.53	262.72	128.02	390.74
	009	Other Supplies	12½	1,783.24	1,598.86	472.13	127.13	3,981.36	1,194.45	5,175.81
	010	Insulated Wire	7	1.87	2 128.56	164.74	3,255.04	5,550.21	4,461.38	10,011.59
	011	Telegraph Apparatus	12½	10,649.02	9,975.72	3,749.68	1,504.51	25,878.93	24,066.90	49,945.83
	012	Miniature Lamps and Accessories	12½	15,522.35	18,259.45	5,305.26	845.77	39,932.83	7,924.75	47,857.58
	013	Battery Supplies	12½	16.86	8.26	22.17	2.78	50.07	.60	50.67
	014	Fuses	12½	59.07	65.13	....	....	124.20	....	124.20
	015	Electric Light Supplies	12½	5.20	1.75	79.59	....	86.54	....	86.54
	016	Electric Light Fixtures	12½	18.27	27.04	2,543.13	1.38	2,589.82	....	2,589.82
	017	Fan Motor Parts	12½	29.45	12.79	....	....	42.24	....	42.24
	018	Electric Novelties	12½	50.73	37.39	6.96	.43	95.51	....	95.51
	019	Irons	12½	4.25	3.55	.68	.04	8.52	....	8.52
	020	Tools	12½	48.84	33.53	61.58	3.35	147.30	....	147.30
	021	Bulbs	12½	13.43	8.13	1,561.58	7.98	1,591.12	....	1,591.12
	022	Miscellaneous	12½	377.98	170.86	49,891.60	655.99	51,096.43	.10	51,096.53
		Total	....	$317,876.38	$328,699.25	$353,596.54	$93,796.17	$1,093,968.34	$1,428,480.81	$2,522,449.15

The amounts in the column headed Total Deliveries are debited the following accounts:			Material Load Per Cent	Shop Deliveries Credited					40 Shop Piece Parts Credited	Total Deliveries
See No	Class	Name		Labor	Labor Expense Loading	Material	Material Expense Loading	Total		
45	000	Plant and Expense Goods Manufactured	12½	$4,568.36	$3,248.07	$1,370.67	$127.82	$9,314.92	$131.43	$9,446.35
	001	General Equipment	12½	94,254.89	63,641.67	60,897.91	7,414.58	226,209.05	311,481.82	537,690.87
	075	Automobile Equipment	12½	189,604.04	133,160.30	233,486.86	29 157.56	585,408.76	837,028.39	1,422 437.15
Finished Mdse Acct.	150	Line Apparatus	12½	3,445.13	2,776.23	11,588.65	1,420.21	19,230.22	11,882.87	31,113.09
	190	Insulated Cable	1.3	300.03	165.25	172.39	63.89	701.56	35.90	737.46
	200	Power Machinery	12½	136.93	91.71	38.28	4.82	271.74	166.78	438.52
	300	Accessories	12½	.60	.35	....	....	.95	....	.95
	400	Batteries	12½	18.44	21.42	56.15	7.01	103.02	....	103.02
	435	Other Supplies	12½	349.93	253.84	205.44	25.74	834.95	276.39	1,111.34
	440	Insulated Wire	7	3,029.06	5,383.20	68,172.12	4,761.40	81,345.78	2,324.41	83,670.19
	450	Telegraph Apparatus	12½	9,641.80	7,241.10	9,136.01	1,140.66	27,159.57	16,842.85	44,002.42
	475	Miniature Lamps and Accessories	12½	3,228.91	2,841.33	2,607.13	170.20	8,847.57	2,341.80	11,189.37
	555	Contract Work	12½	1,556.35	1,311.03	1,592.62	199.02	4,659.02	12.29	4,671.31
		Total Finished Merchandise	....	$310,134.47	$220,135.50	$389,324.23	$44,492.91	$964,087.11	$1,182,524.93	$2,146,612.04
50	001	General Equipment	12½	$11 984.11	$12,787.22	$2,159.24	$3,038.35	$29,968.92	$78,359.71	$108,328.63
	075	Automobile Equipment	12½	10.75	20.45	.15	.21	31.56	.31	31.87
Special Apparatus Acct.	250	Power Machinery	12½	62.04	49.53	1.18	2.25	115.00	137.31	252.31
	475	Miniature Lamps and Accessories	12½	34.38	82.26	.62	.97	118.23	....	118.23
	555	Contract Work	12½	6,940.07	7,338.45	4,223.81	3,738.37	22,240.70	4,017.74	26,258.44
		Total Shop Apparatus	....	$19,031.35	$20,277.91	$6,385.00	$6,780.15	$52,474.41	$82,515.07	$134,989.48
	2–8	Total Plant and Expense Goods Manufactured	....	$179,524.84	$47,104.52	$43,524.62	$3,074.99	$273,228.97	$9,752.79	$282,891.76
		Total Main Plant	7	$826,567.04	$616,217.18	$792,830.39	$148,144.22	$2,383,758.83	$2,703,273.60	$5,087,032.43
	2–8	Total Annexed Plants	....	$24,311.79	$47,117.27	$353,774.80	$10,174.44	$435,378.30	$42,735.50	$478,113.80
		Grand Total	....	$850,878.83	$663,334.45	$1,146,605.19	$158,318.66	$2,819,137.13	$2,746,009.10	$5,565,146.23

work labor into the total productive labor for each week or month, would be especially helpful to the management in increasing piece-work throughout the different departments of the shop.

Standard Reports.—The report, pages 494-495, shows a specimen of such a piece-work percentage report. In the same way, a graph showing the relationship between shop expense and productive labor or man-hours, would provide a basis by the use of which the management could control the current expenses of the shop. The chart on page 496 is a graphic presentation of shop expense. It shows the amount of the actual current expense—as compared with the expense allowable—on the basis of normal operation, for specific degrees of shop activity. As the total shop expense can be reduced only as much as to the extent of the variable expense, the latter is plotted separately from the constant expense, which is shown as a straight line on the lower set of curves, and is made comparative with the allowable variable expense as indicated by the dotted line.

From a report of this kind, the management can immediately picture conditions, from an expense viewpoint, as they actually exist, and if it is found that the amount of actual controllable expense incurred is exceeding that which would be normal for any specific degree of shop activity, steps can immediately be taken to put into effect the necessary remedies. The application of such remedies is, however, a simple matter after the existing condition is known.

"Cost plus Percentage" Bases of Billing.—While a considerable amount of present-day manufacturing is

done on a "cost plus percentage for profit" basis, this method is subject to the severest kind of criticism because it places a premium on inefficiency in manufacturing. The higher the cost, the greater will be the profit to the manufacturer, and the greater, also, will be the dissatisfaction of the customer for whom the goods are being made. In other words, there is no incentive to economize, and there is an incentive to waste both time and material.

Eliminating the Premium on Inefficiency.—The United States Government has found a solution for this problem: namely to contract for work on the basis of an exhibit of costs. Manufacturers who solicit Government business are asked to submit an exhibit of the value of their equipment, on which a certain percentage is allowed for depreciation. This sum is then included with the exhibits of direct labor and material costs, together with an allowance for other indirect shop expenses, in arriving at a predetermined shop cost. To this cost is then added a percentage to cover the general expenses—such, as salaries of officers of the company and other miscellaneous expenses which are incurred in managing the business. The sum of all these figures is then used as a "Bonus Basis." The Government does not pay a percentage on this basic cost or on the actual cost, but agrees to pay a fixed profit, stated in dollars and cents.

When the work has been completed, the actual cost is compared with this predetermined, or basic, cost. If the actual cost is lower, the Government gets a rebate of a certain percentage of the amount so

* John Jones Mfg. Co., Inc.

PIECE-WORK PERCENTAGE REPORT

Number	Total Hours	Expense Hours	Productive Hours	PIECE WORK: Standard and Premium Hours	PIECE WORK: Gang Hours	PIECE WORK: Total Hours	Percent of Productive Hours
101	16,926	4,799	12,127	12,127	.....	12,127	100.0
102	11,944	1,083	10,861	6,064	2,544	8,608	79.2
103	16,357	3,449	12,908	535	3,619	4,154	32.2
104	20,855	3,552	17,303	14,497	.....	14,497	83.7
105	36,725	3,027	33,698	20,366	10,240	30,606	90.8
106	2,572	353	2,219	442	781	1,223	55.1
107	6,748	.....	6,748	5,750	.....	5,750	85.2
108	2,751	1,073	1,678	.....	1,440	1,440	85.8
109	24,817	4,400	20,417	14,810	.....	14,810	72.5
110	35,930	5,444	30,486	22,266	.....	22,266	73.3
111	47,955	7,309	40,646	30,452	26	30,478	74.9
112	7,244	955	6,289	1,277	2,740	4,017	63.9
113	1,453	183	1,270	219	.....	219	17.3
114	38,046	1,087	36,959	.....	36,019	36,019	97.4
115	5,861	778	5,083	2,583	210	2,793	55.0
116	15,685	874	14,811	2	13,071	13,073	88.4
17	18,575	3,869	14,706	10,405	.....	10,405	70.8

118	19,585	6,065	13,520	10,780	.....	10,780	79.8
119	13,141	1,251	11,890	7,971	.....	7,791	67.1
120	927	157	770	513	16	529	68.8
121	11,908	828	11,080	600	9,595	10,195	92.1
122	13,550	1,064	12,486	394	1,696	2,090	16.8
123	57,408	3,313	54,095	6,627	44,701	51,328	94.9
124	16,721	4,905	11,816	1,511	178	1,689	14.2
125	16,881	966	15,915	15,915	.....	15,915	100.0
126	11,728	1,433	10,295	8,945	.....	8,945	87.0
127	750	.....	750	668	.....	668	89.2
128	6,244	1,040	5,204	1,347	.....	1,347	25.8
129	9,465	779	8,686	4,416	3,181	7,597	87.3
130	11,243	1,158	10,085	3,975	2,536	6,511	65.1
131	61,142	5,984	55,158	45,921	.....	45,921	83.2
Total	561,137	71,178	489,959	251,378	132,593	383,971	78.9
SPECIAL DEPARTMENTS							
Annealing	2,126	238	1,888	115	.....	115	6.1
Brass Foundry	1,010	567	443	.....	.....	.....	.....
Lacquering	7,144	3,480	3,664	.....	.....	.....	.....
Japanning	18,225	10,710	7,515	.....	.....	.....	.....
Iron Working	7,873	529	7,344	226	132	358	4.8
Inspection	123,517	29,642	93,875	982	5,193	6,175	6.5
Plating	13,811	747	13,064	1,082	.....	1,082	8.3
Contract	610	242	368	.....	.....	.....	.....
Tinsmith	2,876	2,079	797	.....	.....	.....	.....
Tool	38,754	36,395	2,359	29	.....	29	1.2
Shop Stores	33,782	32,305	1,477	333	.....	333	22.7
Special Work	28,691	1,271	27,420	1,439	.....	1,439	5.3
Grand Total	839,556	189,383	650,173	257,138	137,918	395,056	60.6

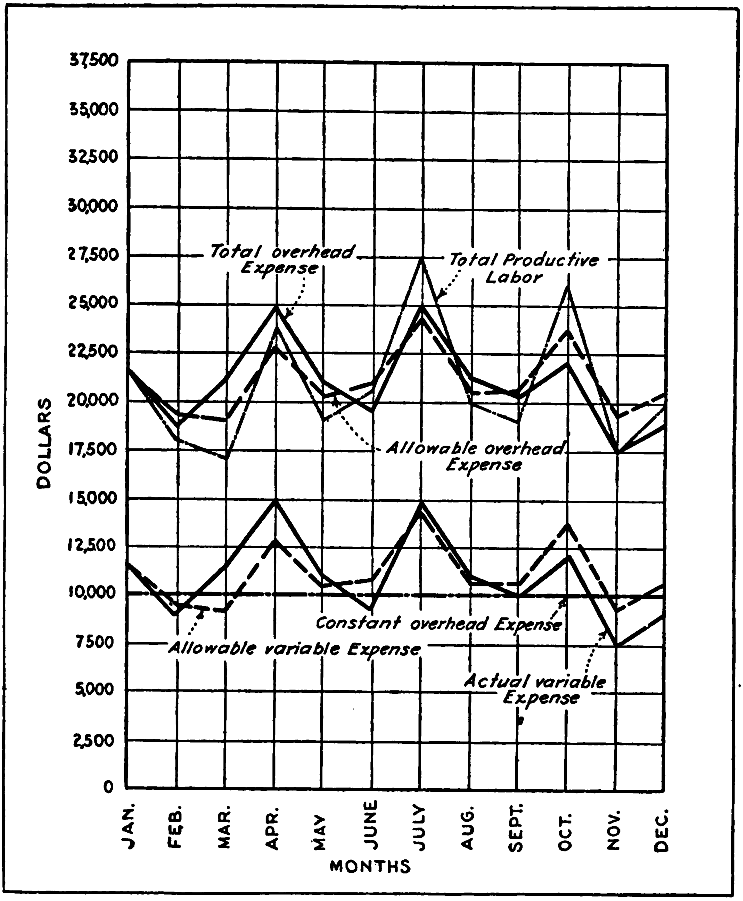


FIG. 78. ABOVE: COMPARISON OF ACTUAL TO ALLOWABLE OVERHEAD EXPENSE FOR DIFFERENT DEGREES OF SHOP ACTIVITY AS REPRESENTED BY PRODUCTIVE LABOR. BELOW: COMPARISON OF ACTUAL WITH ALLOWABLE VARIABLE EXPENSE

saved; if the cost is greater than that shown by the predetermined figures, the Government pays only that same percentage of the increased cost which the manufacturer would have derived from saving in cost.

This method places a premium on economy of manufacture, and makes the manufacturer share with the government any cost in excess of that arrived at in basic-cost figures. This form of contract was originally developed by an official of a large manufactory and was later adopted as a standard form by the United States Government in letting contracts for manufactured war materials.

In concluding this treatise, I am impressed more than ever with the vast amount of standardization work which must still be done before anything approaching uniform cost-finding methods can be possible of attainment. This standardization is possible, however, only through co-operation on the part of manufacturers in all lines of industry. Therefore the greater the co-operation, the more perfect will become this standardization.

INDEX.

Jan 5

Ficker

Industrial cost-finding